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Functional Foods and Natural Products for Obesity Management

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Background

Chronic and noncommunicable diseases remain the greatest threat to humanity. Thus, there has always been a steady increase in the number of patients with cardiovascular diseases and diabetes associated with obesity (1). Currently, billions of people are affected by metabolic and related diseases (2). And one of the largest global health challenges currently facing the world all over is obesity. Being a metabolic syndrome indicator, obesity is closely associated with cancer, cardiovascular disease, hyperlipidemia, hypertension, and type 2 diabetes (3).

The major contributors to the global burden of chronic diseases and their complications are obesity and overweight (4). According to the World Health Organization (WHO) (5), both overweight and obesity involve abnormal or excessive fat accumulation that may impair health. Overweight is when a body mass index (BMI) is greater than or equal to 25 kg/m^2, while obesity is when a BMI is greater than or equal to 30 kg/m^2. Obesity ranks fifth among

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the greatest causes of noncommunicable diseases (6). There are more than 1.1 billion overweight adults, which includes over 312 million obese adults. Obesity is now considered an "epidemic" of noncommunicable pathology, according to the estimates from the International Obesity Task Force (IOTF). The rate of increase in the prevalence of obesity in some industrialized countries is alarmingly doubling or almost tripling among the general population, no thanks to the rapid globalization and proliferated adoption of the so-called Western lifestyle, through the consumption of high-refined carbohydrate and high-fat diets as well as increasing sedentary and inactive lifestyle daily routines. For instance, in the United States alone, about 68% of the adult population are overweight with over half of them having health risks (7, 8).

The rates of obesity, however, are increasing faster in developing countries than in developed countries, with Asia having the highest prevalence rates of obesity among adolescents. The prevalence of obesity plateaued during the first decade of the 21st century in the United States. The overall prevalence of overweight, including obesity, in school children in European countries, was estimated at 20.5%, while the proportions of overweight and obesity were 24.5% and 11.9% in Eastern Asia countries and the Western Asia regions, respectively (9).

From an energy homeostasis perspective, more energy intake than expenditure (exercise) leads to obesity, which, in turn, reduces the quality of life and is also linked closely to a high incidence of lipidemia, diabetes, metabolic diseases, and other several life-threatening disorders (2, 3, 8). Nevertheless, there is a wide variation in the main influencing and determining factors affecting an individual's energy intake and output (10). From a clinical perspective, an excessive accumulation of body fat, which impairs health status, typifies obesity (11).

The rapidly growing body mass indices and waistlines in modern society are also associated with a precarious rise in the prevalence of obesity-associated metabolic imbalances across the globe. Both obesity and metabolic syndrome are continuously putting a strain and a great burden on the global economic and social setting, thus necessitating fundamental but sustainable changes in both lifestyle and nutritional standards (7) such as the adoption of naturally derived ingredients and anti-obesity foods (8).

The human gut microbiome, for instance, comprises trillions of microbial cells colonizing the gut through a close symbiotic relationship to the host while promoting notable immune function and physiological homeostasis. Such a huge prokaryotic population outnumbers the total human body cells by an order of magnitude. The human microbiome also mediates a variety of critical communications between the gut, the brain, and the enteric nervous system. Thus, dysbiosis, which is a perturbation to the gut microbiome, leads to different cognitive, gastrointestinal, and metabolic pathologies (7). A deviation from the normal body weight values due to lack of a balanced diet can also result in a health decline due to weight-related imbalances (12). Strict adherence to healthy eating patterns can improve metabolic health, reduce the risk of cardiovascular diseases and mortality from all causes, and, thus, has been regarded as an effective preventive approach to the transition to metabolic unhealthy obese phenotypes from metabolically healthy obesity (13). It is, therefore, very relevant to appraise the role of functional foods.

Functional foods are wholesome, enriched, fortified, or enhanced foods with potential health benefits beyond the provision of essential nutrients upon regular consumption at efficacious levels and as part of a varied diet (14). Functional foods or nutraceuticals also include processed foods with nutritive value as well as disease-preventing and/or health-promoting benefits (15). This review, thus, discusses the role of functional foods in obesity management vis-à-vis the etiology, clinical presentation and assessment, pathogenesis, complications, current medical management, commonly used natural products and functional foods, studies supporting the anti-obesity potential of functional foods, and common myths about obesity. The data and information on obesity and functional foods were collated from various resources and literature databases such as Google, Google Scholar, Inflibnet, PubMed, Science Direct, Wiley, Scopus, Springer, and Taylor & Francis.

Etiology of obesity

The role of obesity and its contributions to various chronic diseases such as cardiovascular diseases, cerebrovascular incidents, hypertension, type 2 diabetes, hyperlipidemia, and obstructive sleep apnea has been reported in the literature (16). Though excess nutrients in combination with lack of physical activity are the primary causes of obesity, other factors such as cravings, elevated BMI, endocrine disorders, hereditary, mental illness, medications, hormonal disruptors, inadequate sleep, smoking habits, pregnancy at a later age, inherited risk factors, and the variability of ambient temperature also play some contributing roles (17).

The systemic energy metabolism of the body is, however, regulated by the adipose tissues, which are of two primary types, namely, brown adipose tissue (BAT) and white adipose tissue (WAT), as illustrated in Table 9.1. WAT is

Table 9.1 Regulation of the Body Systemic Energy Metabolism

Properties	White Adipose Tissue	Brown Adipose Tissue
Morphology	Spherical	Elliptical
Localization	Subcutaneous, intra-abdominal, epicardial, and gonadal	Interscapular, paravertebral, perirenal, cervical, and supraclavicular
Cell composition	Single lipid droplet, few mitochondria, little endoplasmic reticulum, and flattened peripheral nucleus	Multiple small lipid droplets, oval central nucleus, and a large number of mitochondria
Function	Energy storing and maintenance of energy homeostasis	Heat production and energy dissipation

found in the subcutaneous, intra-abdominal, epicardial, and gonadal parts of the body, while BAT is found in the interscapular, paravertebral, perirenal, cervical, and supraclavicular body parts (18). BAT acts primarily through energy dissipation to produce heat, while WAT, being an energy storage site, is important for the maintenance of energy homeostasis, through endocrine communication. The presence of characteristically multilocular lipid droplets and large amounts of mitochondria is responsible for a high lipid oxidation rate in BAT, while WAT has a single large lipid droplet. Brite or beige adipocyte, an inducible thermogenic adipocyte, has also been found in WAT depots and shares many similar metabolic and morphologic characteristics with BAT (3).

Fat cells, besides storing energy, also secrete a variety of cytokines for the regulation of signal transduction in both adipose tissues and muscles. Adipocytes' differentiation is mainly related to changes in cell morphology, gene expression, and hormone sensitivity. The early adipogenesis stage is enhanced by the expression of certain transcription factors such as peroxisome proliferator-activated receptor γ (PPARγ) and CCAAT-enhancer-binding proteins α (C/EBPα). Sterol regulatory element-binding protein 1c (SREBP-1c) is also involved in the metabolism of fatty acid and lipid biosynthesis (8). Adiponectin suppresses obesity by phosphorylating and activating AMP-dependent protein kinase (AMPK), acting as a regulator for the maintenance of homeostasis of various cellular energetics (1).

The hypothalamus mainly regulates the energy balance by integrating nutritional signals and circulating hormones. The arcuate nucleus (ARC) of the hypothalamus particularly plays a major role in the energy balance control using its primary order neurons: orexigenic neuropeptide Y (NPY)/agouti-related peptide (AgRP) and the anorexigenic proopiomelanocortin (POMC) neurons, which sense glucose and adiposity signals. The NPY/AgRP neurons upregulate feeding behaviors and increase energy expenditures, while the POMC neurons downregulate them. The dysfunction of the melanocortin system is linked with obesity and its associated disorders such as type 2 diabetes mellitus, cancer, cardiovascular diseases, and neurodegenerative diseases (2).

Clinical presentation and assessment of obesity

Obesity is a multifactorial condition with several underlying causes, such as the type and number of calories consumed; energy expenditure; genetic predisposition; epigenetic, metabolic processes; and physiological, sociocultural, and psychosocial influences (11). Some of the clinical manifestations of obesity in males include double chin, gynecomastia, a round face, pendulous abdomen, polydactyly in the foot and hand, while females tend to show features like enlarged breast, round face, early menarche, and pendulous abdomen (19–21).

Obesity is also thought to be responsible for idiopathic genu valgum, which progresses with skeletal maturation (22).

The diagnoses of overweight and obesity are currently accomplished using either BMI or waist circumference calculation. The BMI is usually expressed as a weight (kg) divided by the square of height (m^2) (23). Admittedly, there is a concern over the accuracy of BMI for predicting health at an individual level. Nevertheless, it is useful for population measure with other measures such as waist-to-hip ratio and waist circumference (24). The categories of BMI, according to the National Heart, Lung, and Blood Institute, are shown in Table 9.2.

Table 9.2 The Categories of BMI

Body Mass Index (kg/m²)	Body Habitus Description
<18.5	Underweight
18.5–24.9	Normal
25–29.9	Overweight
30–34.9	Obese (class I)
35–39.9	Obese (class II)
≥40	Extreme obesity (class III)

Source: National Heart, Lung, and Blood Institute (Salazar, 2006).

Pathogenesis of obesity

High caloric diets and inactive lifestyles, according to most epidemiological researchers, are responsible for the increasing prevalence of obesity (25). Obesity is caused by several factors (Figure 9.1), involving a complex interaction among environment, drugs, genetics, epigenetics, hormones, inflammation, metabolism, microbiome dysbiosis, physiological, sociocultural, and several other reasons (11, 26). Multiple candidate genes reportedly implicated in the pathogenesis of obesity include beta-3-adrenergic receptor gene,

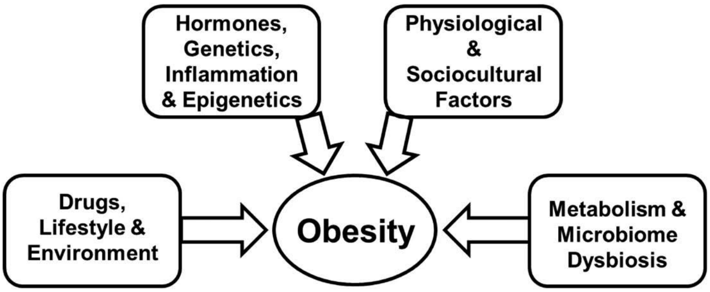

Figure 9.1 *Factors responsible for obesity.*

chromosome 10p, melanocortin-4 receptor gene, peroxisome-proliferator-activated receptor gamma 2 gene, and other genetic polymorphisms, while hormones such as adipokines gut-related hormones and others have also been implicated. Of utmost importance is ghrelin, while some drugs and neuro-endocrine diseases can also lead to obesity (27). Both ghrelin and leptin internally mediate feeding and hunger in humans. Ghrelin, a peptide hormone synthesized by the epsilon cells of the pancreas and fundus lining of the stomach, regulates temporary appetite control, while leptin, another peptide hormone synthesized by adipocytes, regulates long-standing appetite and plays a key role in the storage of fat in the body (17).

Complications of obesity

The economic costs of obesity and its related health consequences are enormous, necessitating several hospitalizations, physician visits, and other related expenses (4). There is a strong link between obesity and most chronic diseases such as cancer, cardiovascular disease, hyperlipidemia, hypertension, inflammation, and type 2 diabetes (3, 24). Obesity-induced inflammatory stress stimulates cytokines release, which, in turn, leads to tissue damage (28). Other complications that have been linked to obesity include obesity-related osteoarthritis (OA), which contributes to increased morbidity and mortality. Two-thirds of obese individuals are reported to have OA, while the incidence of OA tends to increase with an increased BMI. OA is a complex biopsychosocial condition that increases the family financial burden and the healthcare economy. The most significant factor in the pathogenesis of OA is obesity-induced inflammation, as evidenced by the occurrence of OA and impaired metabolism. There are other complications, such as obesity-related systemic factors on the knee and hand. Obesity also contributes to the initiation of the degradation process of the osteoarthritic joint and cartilage (29). Obese children are not only at least twice as likely to be obese adults but also to have an increased risk of cancer, premature death, disability in adulthood, fractures, hypertension, insulin resistance, cardiovascular disease markers, and other psychological issues (24). Impotence and infertility have been linked with abdominal obesity in men, while some reproductive complications of obesity such as dystocia, gestational diabetes, macrosomia, and increased rates of cesarean sections reportedly occur in pregnancy and labor (30). Other common complications of obesity reported in the literature include chronic kidney disease, diastolic heart failure, and nonalcoholic fatty liver disease (31).

Current medical management of obesity

BMI is the basis for most guidelines for obesity treatment (23). Therefore, weight loss remains the cornerstone approach to obesity management. It occurs through the generation of a negative energy balance by consuming fewer calories while expending more energy. The major nonpharmacological recommendations for the management of obesity are behavioral therapy, lifestyle management, diet therapy, and physical activity. The use of a tiered system composed of integrated lifestyle interventions, strengthened obesity education and training, medical treatments, use of advanced electronic health technologies, as well as the involvement of health management centers could potentially improve obesity management (32). Nevertheless, pharmacotherapy, as well as endoscopic and bariatric surgery, are also commonly employed (27, 33). Previously approved drugs for the clinical management of obesity and its related metabolic syndromes, in the long term, include sibutramine, rimonabant, and orlistat. Though only orlistat is being used and approved for long-term obesity treatment, both orlistat and phentermine are the only medications approved by the US Food and Drug Administration for obesity treatment in adolescents (34). According to the literature, however, body weight and drug treatment interact in four distinct ways: unintentional influence of drugs on body weight (as a side effect), intentional and direct effect of drugs for weight reduction, alteration and adjustment of drug's dose for massively obese patients for pharmacodynamic purpose, and the alteration in drug's pharmacokinetic characteristics due to body weight's increase (Figure 9.2). Furthermore, despite obesity being a chronic disease and requiring long-term treatment, weight loss through drugs should be limited to six to eight months (35). The severe cardiovascular adverse effects of some of the drugs, such as fenfluramine, rimonabant, and sibutramine, have culminated in their withdrawal (4, 16). The role of policy makers in tackling the menace of obesity cannot be overemphasized. Governments can enact and enforce laws and regulations to modify the food environment by putting in place some restrictions, regulations, and taxation (31).

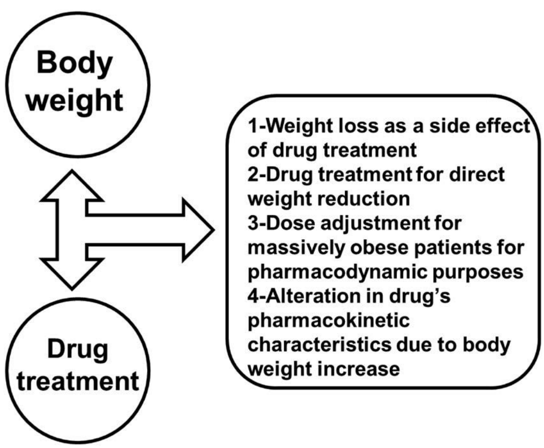

Figure 9.2 *Drug treatment-body weight interactions.*

Natural products and functional foods for obesity management

Despite the controversy regarding the extent to which changes in diet composition drive the obesity epidemic, the consumption of highly processed foods with relatively low fiber but higher levels of sugars and fats, in particular, theoretically affect energy balance. Dietary carbohydrates, especially refined sugars, tend to increase insulin secretion, which, in turn, suppresses lipolysis (36). Excessive food consumption and lack of physical activity could lead to an accumulation of the extra energy as fat (11, 37). On the other hand, several medicinal plants, fruits, and vegetables, which are natural products, are being studied both for preventive and therapeutic management of obesity and as food supplements for weight-loss promotion. Curcumin (from *Curcuma longa* rhizomes, Figure 9.3), capsaicin (from *Capsicum annuum*, Figure 9.4), and celastrol (from *Tripterygium wilfordii* roots) are common examples of plant-derived anti-obesity natural products (4).

Figure 9.3 *Curcuma longa* L. *rhizomes.*

Figure 9.4 *Capsicum annuum* L.

Common natural products such as chromium, cinnamon extract, dark chocolate, dietary fiber, flaxseed oil, ω-3 polyunsaturated fatty acids found in fish, resveratrol in red wine, soy protein, and traditional Chinese herbs have been widely used as dietary interventions against metabolic syndrome (38). On the other hand, the term "functional food" could be traced to the early 1980s when it was coined in Japan. Though there is no universal definition of functional food, it refers to "processed foods with nutritive value as well as disease-preventing and/or health-promoting benefits". In other words, functional foods overlap with other terminologies such as nutraceuticals, medical foods, pharmafoods, probiotics, and designer foods (15). They are enriched, fortified, enhanced, or wholesome foods of either animal or plant origin with several potential health benefits beyond the basic provision of essential nutrients when consumed regularly at efficacious levels and as part of a varied diet (14). Functional foods are potent dietary supplementations that not only support weight management but also protect against the metabolic consequences of obesity.

Honey (Figure 9.5), for instance, is a nutrient-rich, great natural sweetener and medicinal food with several health benefits. The daily supplementation of honey reportedly reversed the formation of hepatic steatosis due to their antioxidative and lipid-lowering effects as well as weight-reducing ability in obese induced rats (39). The anti-obesity potential of honey has been reported in several in vivo and randomized clinical trials (38). The most commercialized honey throughout the world is produced by the Apis bees (*Apis mellifera*). Other honey-producing bees, albeit less known, are the stingless bees within the family Apidae, subfamily Meliponinae, and tribe Meliponini. The Apis bees

Figure 9.5 *Honey.*

are found almost everywhere except in Antarctica and desert parts of the world, while stingless bees, with about 500 species across 32 genera, are mainly found in subtropical and tropical regions. The most common species of stingless bees with high economic importance include *Meliponula togoensis, M. bocandei, M. lendliana, M. ferruginea, Liotrigona* sp., and *Plebeina armata* (40), as well as *Tetragonula laeviceps* and *T. biroi* (41). In Malaysia, the stingless bee *Trigona* spp. produces Kelulut honey, while the rock bee (*Apis dorsata*) produces a tropical multifloral rain forest Tualang honey (42).

The increasing consumption of nuts, on a daily basis, is associated with a lower risk of obesity and less long-term weight gain in adults (43). The consumption of nuts (Figure 9.6), in the long term, is also associated with lower weight gain due to their richness in proteins, dietary fiber, and unsaturated fats, all of which increase thermogenesis and resting energy expenditure. Nuts contain a variety of antioxidants, minerals, phytosterols, and vitamins (44). However, comprehensive information about the safety and potential risks of nuts and seeds is important because of potential and unexpected severe IgE sensitization and allergic reactions among children (45).

Figure 9.6 *Common commercial nuts.*

The anti-obesity of both dietary and medicinal mushrooms has also been recognized. *Auricularia, Flammulina, Grifola, Hericium, Lentinus, Pleurotus*, and *Tremella* species are common dietary mushrooms with beneficial effects on the gut microbiota, while *Ganoderma* and *Trametes* are some of the commonly used medicinal mushrooms. Mushrooms are rich in fiber, high-quality polyunsaturated fatty acids, protein, minerals, and vitamins (17).

Polyphenols, which are found in various fruits, herbs, and vegetables, are one of the most prominent bioactive compounds. The bioavailability of phenolic compounds is the main determinant for their preventative potential (28). Furthermore, methylxanthines and chlorogenic acids (phenolic acid derivatives) from animals and plants (such as caffeine, theobromine, and theophylline) are also getting increasing attention. Their anti-obesity activity is reported to be through nonspecific antagonism of adenosine receptors (A_1R) lipolysis stimulation (11). The common mechanisms of most active ingredients include decreasing adipogenesis and enhancing energy expenditure, interfering with nutrient absorption, modifying the intestinal microbiota composition, suppressing the appetite, and increasing fat excretion (16). Some common natural products and functional foods for the management of obesity are highlighted in Tables 9.3 and 9.4, respectively.

Studies supporting the anti-obesity potential of functional foods

The treatment of differentiated Murine 3T3-L1 cells with some flavonoid compounds (quercitrin, isoquercitrin, kaempferol, and afzelin) reportedly decreased triglyceride levels and significantly downregulated several adipogenic transcription factors, inhibited adipogenesis in pre-adipocytes, reduced intracellular lipid accumulation in mature adipocytes, and resulted in lower expression of lipogenesis-related proteins, while resveratrol reversed free fatty acid-induced insulin resistance (28). *Moringa oleifera* leaves also showed anti-obesity activities through bodyweight loss, improving the lipid profiles, regulating significant genes associated with adipogenesis, insulin resistance, glucose uptake, and hormones in different studies, including clinical trials where it impacted on BMI, low-density lipoprotein, total cholesterol, and postprandial blood glucose (50).

Several microalgae such as *Euglena gracilis, Phaeodactylum tricornutum, Spirulina platensis, Spirulina maxima,* and *Nitzschia laevis* have also been reported to have anti-obesity effects in vitro and in vivo through inhibition of pre-adipocyte differentiation, reduction of de novo lipogenesis, and triglyceride assembly (49).

The extracts of *Coptis chinensis, Mahonia aquifolium, Berberis vulgaris,* and *Chelidonium majus* containing berberine and other alkaloids resulted in reduced adipocyte differentiation, neutral lipid content, and lipolysis rate (51). Ginseng seed oil attenuated intracellular triglyceride levels and accumulation

Table 9.3 Common Natural Products for Obesity Management

Natural Products	Sources	Functions	References
Methylxanthines	Tea leaves (*Camellia sinensis* L.), cocoa (*Theobroma cacao* L.), and coffee beans (*Coffea* sp.)	Multiple physiological effects in the human body	(11)
Chlorogenic acids	Coffee and tea	Anti-inflammatory activity, protective role against diabetes mellitus and obesity through modulation of lipid and glucose metabolism	(11)
Prebiotics & Probiotics	Prebiotics are nondigestible food ingredients. Probiotics such as *Lactobacillus* spp., *Bifidobacterium* spp., and *Akkermansia muciniphila*	For reducing fat deposition and food intake, improving energy metabolism, treating and enhancing insulin sensitivity, and treating obesity	(4, 46)
Calcium Supplements	Dairy products	Inhibition of adipogenic differentiation, lipogenesis, and acceleration of lipolysis	(47)
Cinnamic Acids	Cinnamon bark or benzoin	Improvement of blood lipid profile, hepatic steatosis, and adipose hypertrophy	(48)
Microbial Products	Lipstatin (from *Streptomyces toxytricini*), gut microbiota, and probiotic bacteria	For prolonging satiation, reducing food intake and fat deposition, improving energy metabolism, treating and enhancing insulin sensitivity, and treating obesity	(4)
Resveratrol	Grapes and red wine	Anti-obesity, antidiabetic, and feeding behavior modulations	(25)
Marine Products	Palinurin (from sponge *Ircinia dendroides*), callyspongynic acid (from sponge *Callyspongia truncate*), dysidine (from sponge *Dysidea* sp.), questinol and citreorosein (from sponge *Stylissa flabelliformis*), brown algae, green algae, and microalgae	Increase in energy expenditure, appetite suppressant effect, inhibition of digestive enzyme activity, regulation of adipocyte differentiation, and lipid metabolism	(4)
Epigallocatechin gallate	Green tea	Suppression of pre-adipocyte proliferation, inhibition of adipocyte differentiation and adipogenesis, stimulation of lipolysis and fatty acid β-oxidation	(25)

of lipid droplets in both HepG2 cells and rat hepatocytes (52). Similarly, the extracts of *Centella asiatica* (Asian pennywort), *Morinda citrifolia* fruit (noni), and *Momordica charantia* (bitter gourd) have been reported to inhibit the activity of lipoprotein lipase in vitro (53). The anti-obesity and antioxidant activities of *Cosmos caudatus* ethanolic extract have also been reported (54). Functional snacks with the addition of nanoencapsulated resveratrol prepared

Table 9.4 Common Functional Foods for Obesity Management

Functional Foods	Sources	Functions	References
Honey	A naturally sweet substance produced by *Apis mellifera* bees from different materials	Antioxidative, lipid-lowering effects and weight-reducing ability	(38)
Nuts	Nuts	Increases oxidation, decreases body fat accumulation, increases thermogenesis and resting energy expenditure, delays gastric emptying and subsequent absorption, and suppresses hunger	(44)
Mushrooms	Dietary and medicinal mushrooms	Augments anti-obesity effects, regulates dysbiosis and composition of the microbiota	(17)
Microalgae	*Euglena gracilis, Phaeodactylum tricornutum, Spirulina platensis, Spirulina maxima,* or *Nitzschia laevis*	Inhibits pre-adipocyte differentiation, reduces de novo lipogenesis and triglyceride assembly	(49)

from horse-chestnut, water-chestnut, and lotus-stem starch particles demonstrated significantly higher antioxidant, anti-obesity, and antidiabetic properties than snacks containing no or free resveratrol (55). Some probiotics such as *Bifidobacterium*, most *Lactobacillus*, and some *Bacteroidetes* reportedly show anti-obesity activities, while some dietary plants, such as apple, berries, grapes, chili, soy, sorghum, turmeric, and barley, show anti-obesity efficacy by downregulating obesogenic gut microbiota, upregulating anti-obesity gut microbiota, and increasing the diversity of gut microbiota (56). The justification for concluding causation and treatment effects from nonexperimental data are rarely met in both clinical and public proposals with regards to obesity. Furthermore, observational associations and relationships germane to the causes, prevention, and treatment of obesity are subject to substantial confounding and inconsistency, and are fraught with measurement problems (57). Therefore, it would be relevant to review some of the common myths about obesity and its management.

Common myths about obesity

The sheer number of existing anti-obesity diet regimens and the increasing obesity pandemic would suggest that no single diet has been universally successful at maintaining or inducing weight loss. Most of these dietary programs do follow contemporary principles of weight loss and are grounded on sound scientific pieces of evidence, while others simply recommend the consumption of a particular food type at the expense of other foods or disregard one or more essential food groups (58). Thus, there are a few but common myths and presumptions about obesity, some of which (such as the effects of eating breakfast daily, snacking, and eating more fruits and vegetables) can be tested with standard study designs. Most of the findings seem to be indefinite, while some of the trials have either been completed or are in progress. One of the most common myths about obesity management is that it is very important to set realistic goals for weight loss to prevent patients from becoming frustrated and thus lose less weight. Empirical data, however, indicate no consistent or reliable negative association between ambitious goals and weight loss or program completion. Altering unrealistic goals led to more realistic weight-loss expectations but did not improve outcomes in some studies. Another myth is that breastfeeding is protective against obesity. On the contrary, existing data indicate that though breastfeeding should be encouraged because it has important potential benefits both for the infant and mother, it, however, does not have important anti-obesity effects in children (57). It is a myth that losing weight quickly will predispose to greater weight regain relative to losing weight more slowly. Though rapid weight loss may lead to other serious health problems, only permanent lifestyle changes and adoption of a healthier way of life, such as increasing physical activity and making healthful food choices, promote long-term weight loss. One other common myth is that genes do not contribute to the obesity epidemic. Obesity like other complex diseases, however, is caused by a complex interaction between environmental, genetic, and behavioral factors. Though there is certainly an important genetic component to obesity, changes in environmental influences also have a major impact on the recent epidemic of obesity (59).

Conclusion

Obesity and its complications have several economic, psychological, and sociocultural effects. Diet, lifestyle modification, and exercise are the best approaches for both prevention and treatment. The side effects and high costs of common pharmacological drugs for treating obesity have led to the intensified efforts on the development of alternative drugs from natural products such as active ingredients from plants, microbial sources, and marine sponges owing to their huge health benefits, and remarkable anti-obesity potential. Several functional foods, medicinal plants, fruits, and vegetables have also been studied, both for weight loss promotion as well as preventive and therapeutic management of obesity. The common mechanisms of most active ingredients are interference with nutrient absorption, decrease in adipogenesis and enhance energy expenditure, suppression of the appetite, modification of the intestinal microbiota composition, and increase in fat excretion. Nevertheless, further studies are required to evaluate their efficacy, bioavailability, and safety, in both animal and human subjects. There is also a dire need for systematic targeted clinical studies before the incorporation of these functional foods and natural compounds into the mainstream therapy for obesity management.

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