Chapter 4

Diet, Aging, Microbiome, Social Well-Being, and Health

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Additional information is available at the end of the chapter

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Abstract

Over the past few decades, researchers have established that the human body has a complex ecosystem. It is a social network between our own cells and bacteria and other microorganisms. Bacteria cells in the human body outnumber our own cells by 10 to 1. Despite this huge number, they are usually no threat to us. They offer vital help to many of our basic physiological processes. It is becoming increasingly clear that the microbes in our gut play crucial roles in health and disease. It is likely that the bacterial flora in our body may also influence the aging process. Apart from the influence of bacterial flora in our bodies and the diet we consume, there are certain pharmacological substances such as rapamycin, metformin, and resveratrol that are shown to influence longevity in animals and humans. Calorie restriction is known to increase life span in many animal species. Other factors that influence aging include the role of free radicals, gene modifications, chronic inflammation, and certain spices such as curcumin and capsaicin. Modern life style that promotes obesity and social isolation are other factors that contribute to a number of human illnesses. This paper will present some of the latest findings related to gut flora, aging, and social well-being.

Keywords: diet, microbiome, gut flora, social well-being, health

1. Introduction

The relation between our body and the food we eat on a regular basis throughout our lifespan is a very close and intimate one when compared to all other human relationships. Therefore, many researchers in the field of nutrition have often proclaimed “we are what we eat.” According to anthropologists, our ancestors cultivated the art of cooking more than a million years ago, and the hot and cooked meals made us what we are today [1]. The oversized brain, shrunken teeth, guts, and other peculiar traits of our race arose as *Homo sapiens* turned to cooking in order to improve the quality of the food and easy digestion. Unlike our close cousins, the apes, our race cannot survive on raw food in the wild for a long time. On the other hand, the lifespan of our species is much higher than that of the primates. It is often thought that the increased lifespan of humans during the last couple of centuries is due to the advent of antibiotics and other medical advances, the development of modern urban sanitation systems, and the availability of fresh, nutritious vegetables and fruits round the year. This assumption, however, is being challenged by the findings from the study of mummies a few thousand years ago [2, 3]. These studies indicate that the trend in the increase of lifespan actually started much earlier than what was considered a few decades ago. Compelling data from fields as diverse as physical anthropology, primatology, genetics, and medicine indicate another mechanism for the increased life span. The trend toward slower aging and increased life span started when our ancestors developed defense systems that could ward against the threat from pathogens and irritants in the immediate environment [3]. As human ancestors ate more meat, they evolved defenses against its attendant pathogens. These defense systems may also have contributed to an increased life span as well as diseases of old age. Research is going on at present, and if the above theory is proven correct, it may open new avenues for the development of drugs that may prolong the life span as well as fight the old-age diseases. The new abundance of calories and protein helped to fuel brain growth, and at the same time, such nutritional advances also made it unavoidable to the exposure to various pathogens. The risk of exposure to early pathogens and the subsequent development of immunity favored the rise and spread of adaptations that allowed our ancestors to survive attacks by disease-causing organisms such as bacteria, viruses, and other microbes that seek to invade our tissues.

Agriculture was probably developed by humans around the Nile valley, Indus basin, Mesopotamia, and other regions of early civilizations around 10,000–12,000 years ago. It all started when our ancestors noticed that new plants arise from other plant species. In other words, they learned the secret of seeds. This was probably the starting point of agriculture. Before this new era in human history, the diet of our ancestors was composed of fruits, nuts, and tubers. The hunter-gatherer consumed meat whenever they succeeded in hunting. The early *Homo sapiens* kept moving in order to find food and survive. Once they learned the secret of seeds, they quickly learned to domesticate crops, ultimately crossbreeding different plants to create such staples as wheat, rye, and barley. This in turn resulted in a change in the nomadic way of living. They developed a modern way of living by building villages, towns, and cities. Sugarcane was domesticated in New Guinea around 10,000 years ago. It was a kind of food revolution at that time, and according to New Guinean myths, sugar was an elixir that cured almost everything. The domestication of sugarcane spread slowly from island to island and reached the Asian mainland, the Middle East, and Europe. In India, in olden days, sugar was used as a medicine for headaches, gut flutters, and impotence. Finally, Columbus planted sugar cane in Hispaniola. The slave trade in North and South America is a consequence of sugar plantation.

The eating habits of our hunter-gather ancestors changed drastically since they discovered the secrets and potentials of seeds and plants. Along with the advances in technology and instrumentation, the early practice of agriculture improved tremendously, and our ancestors quickly learned to domesticate crops and animals as mentioned earlier. The percentage of carbohydrates in the diets of our ancestors after the introduction of agriculture increased to as much as 40% compared to fats and proteins. With the advance of industrial revolution about two centuries ago, our dietary habits changed further. The fast-food business became very lucrative, and currently, it is being introduced even in the remote corners of the globe. Alcoholic beverages mainly beer and wine were introduced to human diets around 6000 years ago. The distillation process discovered by the Alchemists in the Middle East several centuries ago led to the production of strong alcoholic beverages such as whiskey and brandy. The introduction of fertilizers and other chemicals in recent decades to boost the production of crops has resulted in the contamination of soil and water. The percentage of heavy metals and other contaminants in the soil and water increased significantly, and this in turn affected plants and aquatic ecology. The future of agricultural practices is likely to be changed drastically in the coming years with increasing population burden. How food is going to transform the future generations is a challenging situation for scientists and politicians. Genetic engineering might be a partial solution. Genetically modified vegetables and grains are already available in many food stores. With the current trend in population explosion, it is crucial to find ways to improve agriculture without destroying the ecology.

For thousands of years, humans shared the planet with Neanderthals, primates, and a large number of other species which are extinct. Our species were also at a risk of extinction about 74,000 years ago when a super volcanic eruption took place in Indonesia. The human population at that time was only a few thousands. The heroic ascent of man took place around 35,000–50,000 years ago. At around the time of introduction of agriculture, the human population was around one million [4]. During the industrial revolution about 150–200 years ago, the human population became one billion. After the Second World War, dramatic changes took place in the history of *Homo sapiens.* This included population expansion, globalization, mass production, technological and communication revolutions, improved farming methods, and advances in health sciences. It is predicted that by 2050, the human population would be increased to 9 billion. It is the age of man: the *Anthropocene* [4].

In this mini-review, I would describe the current knowledge about human aging and the importance of bacterial flora in our bodies that have profound influence in our health and social well-being. It will also describe some of the latest advances in order to deal with the aging populations throughout our globe.

2. Diet, pharmaceuticals, and aging

Any comparative study of diet and aging depends on the availability of accurate criteria for defining and assessing the aging processes. Currently, a lot of information is available about human aging. Burnet in 1974 indicated a linear relation between age and logarithmic values for total death rates in different populations [5]. The exponential increase in mortality rates with age was first noted by Gompertz in 1825 [6]. Research on aging in the late 1960s in Sweden and the United States showed similar patterns. Mortality for both countries was higher for men from birth up to the highest ages, whereas the mortality rate at age 10 shows for both men and women the lowest figures of all age groups. At age 20, there is a limited additional increase that is more pronounced in males than in females. It may have a special significance when it is realized that the blood pressure in normal populations exhibits an almost identical plateau at age 20 [7]. These data are consistent with a genetic control hypothesis for aging which is in turn under environmental influence.

During the 1960s and 1970s, tobacco, alcohol, sugar, coffee, and some other constituents have been singled out as factors increasing the risk of developing diseases of the old age including cardiovascular diseases, diabetes, and cancer. Mormons in Utah, USA, and other parts of the world are forbidden to drink alcoholic beverages and coffee and to smoke. It seemed of interest to compare the mortality rates for Mormons and other groups. Studies by Brown and Forbes in 1976 showed that mortality rates of Mormons in Utah (USA) and a control group in Montreal (Canada) showed an identical pattern [8]. The similarity was pronounced after the age of 40 when cancer and cardiovascular diseases are the dominating cause of death [8]. Similar results were found in Sweden. Does this mean that smoking habits and drinking alcoholic beverages and coffee are less important than other factors? Later studies, however, have proven that drinking, smoking, and the consumption of fatty foods have a profound negative influence in the development of diseases of the old age. Studies in Sweden and other countries during the 1970s suggest two separate selection processes: one from conception until the age of 10 and the other from 10 until death. The early selection period may be more susceptible to social and general living conditions than the second. Those surviving the first 20–30 years of age in Australia 100 years ago showed a lower rise in mortality rate with age than the case in the general population today [5, 9]. These findings indicate that aging might be a continuous process [10]. In China arteriosclerosis was not considered to be a clinical problem in the 1930s, but today there is a high incidence of cardiovascular disease in China [11]. The Chinese diet was considered to be "non-atherogenic." The diet at the present time is basically unchanged, but the life expectancy, which 60–70 years ago was 33 years or less, is now 70 years. Some decades ago, chronic alcoholism appeared to protect against cardiovascular diseases until it was found that the low incidence of the diseases related to the shorter life span of alcoholics [12, 13]. Another paradox related to alcohol consumption is the high level of high-density lipoprotein (HDL) found in the blood of alcoholics [12, 13]. HDL is found to have some protective effect against the development of cardiovascular diseases.

It was only during the latter part of the nineteenth century that the mean life expectancy at birth in Sweden and some other European countries reached 50 years. The decreasing infant mortality, which still contributes to a prolonged life expectancy in Sweden and other affluent countries, suggests that the diet consumed by the mothers during the most susceptible phase of life has no obvious inadequacies. With the exception of infections and toxic agents, most environmental factors are assumed to affect human genes only slowly. Can the prevailing causes of death due to cardiovascular diseases and cancer be eliminated? The latest research indicates that they cannot be eliminated, but can be postponed. Hayflick in 1976 estimated the increase in life expectancy when the old-age diseases are eliminated [14]. According to

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his estimate, a total elimination of cardiovascular diseases would lead to an increase in life expectancy at birth of 10.9 years. The elimination of cancer on the other hand would lead life expectancy by only 2–3 years. Studies by Pearce and Dayton in 1971 showed that populations consuming a diet that is high in polyunsaturated fatty acids died less frequently from cardiovascular diseases than people on normal diets [15].

In order to understand the interaction between the genetic basis and the environmental factors at different age levels, it seemed desirable to develop a "biological age indicator" system. Burnet's hypothesis mentioned earlier indicating a genetic control of aging giving the thymus and the circulating lymphocytes a leading role seems to be in agreement with the findings described above. At the present time, based on a number of studies employing modern technology, it is doubtful whether genes alone are involved in the aging process. Genes alone are unlikely to explain all the secrets of longevity. Genes account for only 25% of longevity. It is the environment too, but that does not explain all factors involved in the aging process either. **Table 1** shows some of the relevant factors associated with aging.

Retardation of growth in experimental animals by calorie restriction was first described by McCay and his co-workers in 1939 [16]. Tannebaum and Silverstone showed that diet restriction retards the appearance of various types of cancer and thus the diet slows down the aging process [17–20]. Ross and his co-workers in 1976 showed that a food intake in grams was negatively correlated with age [21]. They concluded that the conditions in early life seem to govern the life span and to interweave with factors that regulate susceptibility to age-related diseases. So far, nobody has established a particular nutrient such as an amino acid, a mineral, a trace element, a vitamin, or total energy as the limiting factor. Although eating sparingly may have been less a choice than an involuntary circumstance of poverty in a number of places in the world during the nineteenth and twentieth centuries, early research has suggested that

Agent/process	Known mechanism
Calorie restriction	Gene modification
Rapamycin and related compounds	mTOR modification
Metformin	Glycation of proteins
Resveratrol	Antioxidant, acts on sirtuins
Free radicals	Damage DNA and proteins
Gene modification	Acts on regulating genes
Chronic inflammation	Cytokine excretion
Young blood	Restoration of GDF 11
Drugs	Gene/hormone activation
Spices (e.g., curcumin, capsaicin)	Antioxidants, act on sirtuins

Table 1. Factors associated with aging process.

a severely restricted diet is associated with a long life. Recent research, however, has undermined the link between longevity and caloric restriction.

Rapamycin was isolated from the soil of Easter Islands during the late 1960s. The soil contained a bacterium that made a defensive chemical that was shown to prolong the life span of several animal species. This substance has been shown to interfere with the activity of a protein called target of rapamycin (TOR) [22–25]. This protein is a now a subject of intensive research around the world. A number of recent studies have shown that suppressing the activity of the mammalian version of the protein (mTOR) in cells can lower the risk of major age-related diseases, especially neurological disorders such as dementia [19]. Researchers at Harvard University, USA, have found this protein also acts as a nutrient sensor [22–25]. When food is abundant, its activity rises, prompting cells to increase their overall production of proteins and to divide. On the other hand, when food is scarce, it helps to conserve the resources. Thus, inhibiting the functions of mTOR may oppose the aging process. Rapamycin, unfortunately, has many side effects in humans, and a few drug companies are developing molecules like rapamycin that have fewer side effects. The discovery that the aging process, previously thought to be intractably complex, could be dramatically slowed by altering one or several genes (gerontogenes) had helped make gerontology a very exciting and hot topic. It also suggests that aging can be retarded by drugs as mentioned above. Such drugs that slow aging could act as preventive medicines that could postpone or retard the late-life disorders including dementia, osteoporosis, cancer, and cataracts. They can be compared with modern drugs for cardiovascular diseases that have pushed off conditions such as early myocardial infarcts [22–25].

Metformin is a very common drug that is prescribed to patients with diabetes throughout the world. Millions of people have taken it for long periods in order to control blood glucose. Considerable efforts have been made since the 1950s to understand the cellular and molecular mechanisms of the action of metformin. The main effect of this drug from the biguanide family is to decrease hepatic glucose production, mainly through the inhibition of mitochondrial respiratory-chain complex 1. In addition, it activates the AMP-activated protein kinase (AMPK) [26]. Its mechanism of action is not yet absolutely very clear at present. It has, however, been shown that metformin inhibits the TOR pathway. It also activates another aging-related enzyme called AMPK, which is likewise stimulated by calorie restriction. Metformin also has been shown to activate certain genes associated with aging in experimental animals. Recent studies at the university in Cardiff University in Wales, UK, showed that patients with type 2 diabetes who took the drug lived on an average 15% longer than a group of healthy controls [26, 27]. Scientists speculate that metformin interferes with a normal aging process called glycation in which glucose combines with proteins and other molecules gumming up their normal functions. This finding is interesting because people who have diabetes, even if it is well controlled, have somewhat shorter life span than their healthy counterparts. Only time can tell us if metformin can retard aging.

Resveratrol is a molecule that is found in grapes, other berries, and red wine. This molecule has attracted considerable attention in recent years in research concerned with aging process. Researchers have found that this molecule can activate enzymes such as sirtuins that regulate some of the genes that control aging process. In animal models, resveratrol appears to activate one of the sirtuins, STRT1, which switches on multiple chemical pathways that mediate hormetic effects [28]. It also guarded the brain and spinal cord against damaging effects from the cutting off of blood flow that occurs in some types of stroke [28]. Not all of the research is uniformly positive. Scientists are uncertain about the specific pathway that resveratrol may be involved in the death of neurons. Moreover, recent studies in rodents have failed to show an anti-aging effect. It is possible that resveratrol and similar molecules modify genes associated with aging. Further studies are in progress.

Reactive oxygen species (ROS) have attracted considerable attention in scientific circles during the last few decades. Metabolites of dioxygen such as superoxide, hydrogen peroxide, and hydroxyl ions are potentially damaging to biological systems. Univalent reduction of dioxygen produces superoxide which can be converted to hydrogen peroxide and hydroxyl radical. Superoxide dismutase which is a zinc-containing enzyme and other antioxidants may be useful in combating cell damage. A few important trace elements such as zinc, copper, iron, and selenium are important components of enzymes that deactivate the damaging effects of ROS and other free radicals. Although the first paper showing the association between trace elements such as manganese and disorders of the central nervous system appeared more than a century ago, much new information has accumulated in recent years concerning the role of free radicals in the etiology and pathogenesis of several neurological diseases. These include Parkinson's disease, dementia, amyotrophic lateral sclerosis, Down syndrome, and Huntington's disease. The similarities in the histopathological changes and the coexistence of these diseases implicate close relationships among the mechanisms of these illnesses. Age is certainly one of the deciding factors in the appearances of degenerative diseases of the central nervous system. The causes of these, diseases, however, are multifactorial. The reduction in the volume of brain is the most evident abnormality in most of the degenerative diseases mentioned above although the distinction between the changes due to the normal aging of the brain and the pathological changes observed in many degenerative diseases of the brain is arbitrary. The role of ROS and other free radicals in the premature aging process and the subsequent increase in the incidence of a number of degenerative diseases has attracted considerable attention during the last few decades. Oxidant stress caused by free radicals is known to disturb calcium homeostasis by altering the calcium transport across the cell and mitochondrial membranes. Mitochondrial DNA is particularly susceptible to oxidative stress, and there is evidence of age-dependent damage and deterioration of respiratory enzyme activities with normal aging. If free radicals are associated with deterioration of neurons and the aging process, it is probable that high levels of antioxidants may prevent such damage. Fruits, vegetables, and nuts are very rich in many antioxidants, and people who regularly consume a diet rich in antioxidants are known to have healthier brains and to be less likely to suffer from neurodegenerative diseases [29]. On the other hand, supplementations of synthetic antioxidants such as vitamin C, E, and A in experimental animals have failed to prevent or ameliorate diseases. Recent studies by Mattson have shown that the beneficial effect of fruits and vegetables are due to the natural pesticides that plants produce [29]. Plants have developed an elaborate set of chemical defenses to ward off insects. When we consume fruits and vegetables, we are exposed to such chemicals in very low doses. Exposures to these chemicals cause a mild stress reaction that lends resilience to cells in our bodies [29]. Adaptation to these stresses accounts for a number of health benefits, including healthy aging. This is currently a very exciting area of research.

A number of genes that control the body's defenses can dramatically improve health and prolong life. Recent studies indicate that a family of genes involved in an organism's ability to withstand a stressful environment has the power to keep its natural defense and repair systems going strong, regardless of age [29]. Many recently discovered genes have been found to affect stress resistance and life span in many laboratory organisms suggesting that they could be part of a fundamental mechanism for surviving unfavorable environment. Scientists studying groups of people genetically isolated by location or culture have found gene mutations that seem to prevent diseases that most often shorten life. **Table 2** shows some of the most important genes associated with aging.

All the known genes associated with the aging process are not included in the table. Along with the recent advances in gene technology, we are definitely going to find more genes that will influence aging.

Chronic inflammation is another component associated with aging. It is stress-related and associated with anxiety. It is well-known that stress modulates the sympathetic nervous system and results in the secretion of hormones such as epinephrine and cortisol. These hormones signal the immune system to release cytokines. These molecules alert leucocytes and other cells to deal with inflammatory process. When one is chronically stressed, the body is flooded with inflammatory chemicals. The chronic inflammation may lead to the development of cardiovascular diseases, cancer, and brain deterioration. Meditation and mindfulness exercises have recently been shown to have positive effect to combat chronic stress. Regular meditation may also reduce the loss of gray matter in the brain [29, 30].

Gene code	Known function
SIR2 (sirtuin family)	Master regulators of survival
CETP	Reduces risk of dementia and hypertension
APOC-3	Lowers risk of CVD and dementia
GHR	Suppresses insulin-like growth factor
	Lowers fat in the blood
FOXO3a	Lowers the incidence of cancer and heart disease
CAT (catalase)	Detoxification of hydrogen peroxide
AMPK	Metabolism and stress response
KLOTHO	Insulin, IGF 1, and vitamin D regulation
DAF/FOXO proteins	Growth and glucose metabolism
Telomerase genes	Effect on chromosomes

Table 2. Some genes that are currently known to be associated with aging and disease.

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A recent discovery in mice shows that young blood contains a protein called GD11 [31]. This protein has been shown to rejuvenate an aging animal by stimulating nerve cell growth and retarding myocardial enlargement. No such studies are done in humans. It is interesting to see if people with long life span have increased levels of GD11 in their blood. It is likely that people with low levels of this protein may be at risk of developing chronic diseases at an early stage and this shortens the life span.

As mentioned earlier, a number of pharmaceutical companies are involved in the development of drugs that may influence the aging process. Molecules similar to rapamycin are of great interest. Novartis has already shown that a molecule called everolimus that is chemically similar to rapamycin may retard the age-related chronic diseases in humans. Side effects and cost are the limiting factors. With current state of knowledge concerned with human aging, it is likely that many new drugs may be available in the future for postponing the aging process. The trend is already visible. Lower calorie intake, regular exercise, eating a variety of fruits and vegetables, and getting proper sleep are probably better than drugs to enjoy a healthy old age.

3. Diet and microbiome

Scientists in the past believed that the human body is capable of regulating the metabolic functions through complex network of enzymes and the immune system. Over the last few years, researchers have found out that the human body has a complex ecosystem. It is a social network between our own cells and bacteria and other microorganisms. Trillions of bacteria inhabit our skin, genital areas, mouth, and intestine. Bacterial cells in the human body outnumber our own cells by 10 to 1. Despite this huge number, they are usually no threat to us. Instead, they offer vital help to many of our basic physiological processes [31]. Employing the latest gene technology, researchers have characterized most prevalent species of microbes in our body. It is becoming increasingly evident that the microbes, mainly bacteria, in our guts play crucial roles in health and diseases. Modern lifestyle has definitely contributed in upsetting the normal flora of our guts, and many diseases such as certain autoimmune disorders, obesity, and gastrointestinal problems are probably due to this imbalance. Compared to many developing and poor countries of our planet, the bacterial flora of the people living in affluent countries is certainly different, especially women. This is especially the case in the microbiota of the genital tract. Urinary tract infections are far more common in the females of industrialized countries than that of women living in poor countries in Asia, Africa, and South America.

Newborns through normal delivery are sterile at the time of birth. While passing through the birth canal, babies pick up some of the bacteria from the mother, and they are gradually exposed to other members in the family including pets and other domesticated animals. During the last few decades, Caesarian deliveries have become very common in both developed and developing countries, and this practice has definitely contributed to the difference in quality and quantity of microbes in infants. By late infancy, our bodies support one of the most complex microbial ecosystems on our planet. As mentioned earlier, modern gene technology has helped to create a catalogue of the entire human microbiome. It has turned out that the bacterial genes outnumber our own genes by a factor of 1–150. The latest studies also reveal that each individual belonging to the human race has his/her own bacterial make-up [32]. Most people associate bacteria with diseases such as respiratory tract and urinary tract infections. It is only during the last few decades that we have learned that we host to a number of friendly microbes as well.

Most bacteria found in the healthy guts of humans are beneficial to us. For example, the gut bacteria help to produce vitamins such as cobalamins and break down indigestible food components so that we can make use of them. Humans need vitamin B12 for cellular energy production, DNA synthesis, and the manufacture of fatty acids. Gut bacteria can also break down starch and fiber. They are normally called as commensals. Our own cells in the gastrointestinal tract cannot handle indigestible food components such as starch. At the same time, it must be pointed out that even the most beneficial bacteria in the gut can cause serious disease if they are translocated to some other parts of the body than where they are supposed to be. I shall describe the influence of the two commensals in order to show their importance in human health and social well-being.

Two bacterial species, namely, *Bacteroides thetaiotaomicron* and *Helicobacter pylori*, play crucial roles in digestion and the regulation of appetite. The first one degrades complex carbohydrates. The human genome lacks most of the genes required to synthesize enzymes that degrade carbohydrates as mentioned earlier. The second one *H. pylori* is notorious in the sense that they cause dyspepsia, a dysfunction discovered already in the 1980s by the Australian physicians Marshall and Warren. This is one of the few bacteria that seem to thrive in the acidic environment of our stomachs. After this discovery, it was common to treat peptic ulcers by antibiotics, and the incidence of bacteria-induced peptic ulcers dropped to 50%. Apart from regulating the acidity in the stomach, this bacterium also regulates appetite. The stomach of our species produces two hormones, namely, ghrelin and leptin, that regulate appetite [32]. Patients who are treated with antibiotics and proton-pump inhibitors to eliminate these bacteria from the stomach usually gain weight gradually, and it has been suggested that the obesity seen even in children in affluent countries like the United States is related to elimination of this bacteria from our stomachs. A recent study in the United States shows that only 6% of children have these bacteria. Repeated prescription of penicillin and other antibiotics for minor respiratory illnesses and ear infections is probably the main reason for this imbalance. Eradication of this bacteria from the stomach by proton-pump inhibitors and antibiotics has become the common practice in most countries at the present time, and with time, it is likely that this beneficial bacteria is totally eradicated. It is uncertain at the moment whether the elimination of these bacteria alone will be one of the major causes of obesity in the future.

So far, I have only described the influence of two commensals in our body. What about the trillions of others? A healthy, mature, immune system depends on the constant intervention of beneficial bacteria in the gastrointestinal tract. *Bacteroides fragilis* and the *Lactobacillus* species are another group of gut bacteria found in a majority of human population [32, 33]. These microbes are known to help to keep the immune system in balance by boosting its anti-inflammatory arm. Because of lifestyle changes, especially after the introduction of fast foods over the last few decades, a number of beneficial bacteria species in our guts are disappearing. The microbiota of Westerners is significantly reduced in comparison to rural individuals living similar lifestyle to our Paleolithic ancestors and other free-living primates [34]. What has happened to modern lifestyle during a short period of time has completely changed our association with the microbial world. The rise in a number of autoimmune disorders and obesity is closely associated with the imbalance in our gut flora. Despite the advances in health sciences during the last century, we are still far away from understanding the role of microbiome in health and disease. Intensive research is taking place throughout the world to learn more about the microbiota and health.

4. Food and social well-being

According to the World Health Organization (WHO), the fundamental cause of obesity and overweight is an energy imbalance between calories consumed and calories expended. Physicians and other health personnel throughout the world have advised their overweight patients to eat less and exercise more. In spite of such efforts, the prevalence of obesity or the accumulation of unhealthy amounts of body fat has climbed to unprecedented levels. Currently, 30% of the US populations are overweight, and the health budget has increased to astronomical levels to treat diseases associated with obesity. Similar trends are noted in other affluent countries. Even in fast-growing countries such as China, India, Brazil, Russia, and South Africa (the so-called BRICS), overweight-associated diseases are on the increase. In the good old days, fat babies were considered to be healthier than the thin ones. Even at the present time, many mothers who attend the child care centers in the Western countries are worried when their kids are underweight according to the current growth charts. In many Asian countries, a round belly is considered to be a sign of opulence. The fast-food revolution mentioned earlier is probably the most dominant cause of overweight in affluent countries. If the current trend continues, obesity will soon surpass smoking in most countries as the biggest contributing factor in the development of chronic diseases and early death. For a species that evolved to consume energy-rich food in the environment where starvation was a constant threat, losing weight and staying trimmer in an affluent world fueled by marketing messages and cheap empty calories is, in fact, very difficult. Recent research findings are yielding new and important insights about social and behavioral factors that influence diet, physical activity, and sedentary life. The general public love to believe and react to neat and cheap fixes, and the mass media oblige by playing up new scientific findings in headline after headline as if they were the solutions. Behavior-focused studies of obesity and diets have identified some basic conditions that seem correlated with greater chance of losing weight and keeping it off. These include initial assessment, self-monitoring, behavior shifts, and support from others with similar problems. Unfortunately, people are getting more and more isolated and live a sedentary life mainly due modern lifestyle.

As mentioned in the earlier section, our body hosts trillions of microorganisms, especially in the gut. Bacteria and other microbes dwelling in our body produce molecules that can interact with our central nervous system in ways that appear to affect our anxiety and stress response. Some of these molecules resemble hormones and neurotransmitters. Gut microbiome appear to alter gene activity, especially in the brain, as mentioned earlier. These molecules may also be involved in memory and learning. The mood changes in an individual are known to relate to the activity of the gut microbiota. This again depends on the type and quantity of diet we consume on an everyday basis. Evidence supporting a connection between gut ecology and human brain is trickling in. It is very likely that the microbes on our skin interact with those in the gut and thereby influence our behavior.

The final question is about the kind of diet that could provide a healthy long life. Apart from healthy aging, an ideal diet should have components that can prevent illnesses such as cardiovascular disease and diabetes. Such a diet should be rich in vegetables, fruits, and whole grains, with moderate amounts of protein and less added sugars and bad fats. It is impossible to point out one single nutrient in certain diets that provides health benefits such as reduced death from cardiovascular diseases, and many experts on human nutrition think that it is the result of various foods in combination that provide the most benefit. The important thing is to cut back on how much we eat overall. Therefore, a diet low in added sugars and bad fats, with moderate protein intake, and high in plants, nuts, and fruit, can currently be considered good for healthy aging and social well-being.

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