Therapeutic Potential of Gut Microbiota Modulation in Non-Communicable Diseases

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Abstract: The human gut microbiota is essential to human well-being which contains a complex set of microorganisms that performs important bodily activities and maintains homoeostasis within the body. Among the most potent factors influencing the composition and activities of the gut microbiota is diet. The intricate interactions between the immune system and the intestinal barrier underscore the crucial role that nutrition plays in both the aetiology and management of various illnesses. The term dysbiosis refers to alterations and imbalances in the makeup of the gut microbiota, which can result in a variety of disorders. Maintaining good health and preventing non-communicable diseases (NCDs) depend heavily on diet. Non-communicable illnesses are prevalent throughout the world and account for 41 million annual deaths, or 74% of all fatalities globally. Noncommunicable diseases (NCDs) comprise cancer, cardiovascular disorders, cognitive impairments, and metabolic disorders and a number of factors, such as the environment, microbes, the surrounding area, and food, contribute to the spread of NCDs. Globally, NCDs account for the majority of death cases. Diet is a major factor in controlling the variety and abundance of gut microorganisms. Diet is also thought to play a major role in the establishment of the gut microbiota, which contributes to the pathophysiology of non-communicable diseases. This review aims to provide an overview of the therapeutic benefits of diets on different NCDs and their function in gut microbiota modulation. The importance of nanoparticles in the modelation of gut microbiota and their effects also addressed.

Keywords: Non-communicable diseases; diabetes; cancer; gut microbiome; diet, nano-materials;

1. Introduction

The natural habitat of a varied and dynamic microbial ecosystem is the human gut; the maintenance of adult health and proper growth and development depend on these microbial communities. In addition to giving the microbial communities food and habitat, the host gains a great deal from its symbionts, which support trophic, defence, and metabolic processes [1]. The term "microbiota" describes all of the microorganisms that live in a certain area. In addition to bacteria, this population also includes fungi, viruses, archaea, and protozoa.Recently, the gut flora has drawn a lot of attention from the scientific community.Numerous uncommon human diseases, including lumina inflammatory bowel disease (IBD) and IBS, metabolic conditions like diabetes, obesity, allergy problems, and neurodevelopmental ailments have all been linked to the gut microbiota. But not all of these connections are backed up by a lot of data [2]. Changes in the range of microbiome in the gut are most likely because of the fast evolving environment and lifestyle. Alteration in the equilibrium of the intestine and gut microbiota may affect the immune-mediated, metabolic, and physiological systems in addition to other processes linked to human health. Many inflammatory disorders, including obesity, IBD (inflammatory bowel disease), allergy sickness, respiratory issues, and associated noncommunicable diseases (NCDs), are becoming more common as a result of changes in the makeup of microorganisms in the body [3]. It is becoming more and more clear that human well-being and gut flora are related. It is well acknowledged that a host's gut flora plays a major role in determining their well-being. Firmicutes and Bacteroidetes are the two primary taxa that comprise the typical human gut microbiome [2].

The human gastrointestinal system is the site of some of the largest interactions (250–400 m^2) between the recipient, environmental factors, and antigens. The GI tract breaks down over 60 tonnes of food in a person's lifetime in addition to other environmental germs that can adversely damage gut health. The microbiota assists the host in many methods through a range of bodily processes, including maintaining the health or the growth of the epithelium in the gut, utilizing energy, fending off infections, and regulating host immunity. However, these processes may be hindered by dysbiosis, or a change in the community of microbes [4]. Throughout their life, a person is susceptible to a number of issues, such as poor nutrition, medication, and infections. A compromised ability to revert to the pre-challenge background could lead to dysbiosis [5]. Many people view urbanization as a double-edged sword: This has claimed to have negative side effects for health outcomes related to non-communicable diseases [6]. Approximately 43% of people on Earth resided in cities in 1990; by 2021, that number had risen to almost 57% [7]. The microfloras are quite delicate, but they carry out a multitude of helpful tasks. Within twenty-four hours, the entire population of bacteria is altered by a small alteration in nutrition, a stressful environment, pH changes, or the use of antibiotics [8]. Furthermore, it is now known that food has a major short- and long-term impact on the makeup of the microbial community. This should open up new possibilities for manipulating health through diet [9].

Cities around the world are becoming more and more populated, particularly in developing nations like Asia and Africa. Simultaneously, non-communicable diseases (NCDs) are on the rise globally; this trend is intimately related to the manner in which urbanization has altered people's environments and ways of life [7]. Recent estimates from the WHO indicate that 68% of deaths worldwide in 2012 were attributable to NCDs, with over 40% of those deaths being deemed "premature," or happening before the age of 70 [6]. Anaerobic bacteria, which are mostly present in the intestine, make up the gut microflora. The microbiota or microflora in the gut is crucial for the host's defense. They help break down necessary molecules, support development and proliferation, help prevent sickness and infection, and enhance the gut's environment all while maintaining a healthy environment. A rise in the quantity of microorganisms in the small intestine may result from disruptions to the healthy gut microbiome. Studies have also connected these bacteria to a wide range of conditions, such as non-communicable diseases like tumors, strokes, diabetes, hypertension, and coronary heart disease [8]. The increasing prevalence of noncommunicable illnesses and their connections to the health and anatomical abnormalities of the gut microbiome are covered in this review. The review focuses on novel approaches for managing non-communicable diseases (NCDs), including the feasibility and potential for altering an individual's probiotic and prebiotic consumption and the potential effects on the pathophysiology of the disease. The recent advances in the usage of different nano particles and nano materials in the regulation of intestinal microbiota are also included.

2. Overview

2.1. Non-Communicable Diseases

"Non-communicable diseases" are persistent illnesses that arent passed on spontaneously from person to person (NCDs). NCDs includes conditions like cancer, autoimmune diseases, metabolic problems, and mental health issues [7]. Illnesses known as non-communicable diseases (NCDs) develop gradually over a long period of time. Environmental, genetic, physiological, and behavioral variables work together to create non-communicable diseases (NCDs). According to the World Health Organization (WHO), non-communicable diseases (NCDs) are the major cause of mortality worldwide, accounting for 71% of all deaths annually. Cardiovascular illnesses (17.9 million), malignancy (9.0 million), Type 2 diabetes (1.6 million), and respiratory illnesses (3.9 million) are the four NCDs that result in the greatest number of deaths each year [10]. Non-communicable illnesses continue to be a significant source of death and disability in India, which is a serious public health concern. The trend of non-communicable illnesses is primarily being caused by changes in the general population, changes in lifestyle, and an acceleration of urbanization. The following are the primary non-communicable diseases (NCDs):

• Cardiovascular conditions and stroke

• Type 2 diabetes mellitus and cancer

• Chronic lung conditions

• Infections and allergies [11]

Noncommunicable diseases (NCDs) are indeed on the rise and constitute some of the globe's leading causes of death, particularly in emerging and recently urbanized nations. By 2050, it is predicted that more than 68% of people on Earth would reside in cities [7].

2.2. NCD - Causes and Risk Factors

Non-communicable diseases, or NCDs, have become a significant health concern for all levels of governance as well as for community at large due to their high death rate. Five categories can be used to group the primary risk factors for noncommunicable diseases (NCDs): hereditary, environmental, self-management, and variables related to medical conditions [10]. WHO classification of risk factors for NCDSs

1. Use of tobacco in any form within the previous 30 days (WHO, 2008).

2. Previous 30-days alcohol consumption of at least one drink (WHO, 2008).

3. Physical inactivity - Individuals over 18 who do not fall under any of the subsequent categories: A person must engage in at least 600 MET of physical activity each week in order to satisfy the WHO's 2013 requirements. Engage in moderate exercise for two hours each day, strenuous exercise for seventy-five minutes each day, or a combination of the two.

4. >5 grams (2 gm sodium) of salt intake (WHO, 2012)

5. Consume no more than 400 grams, or five servings, of fruits and/or veggies per day. (WHO, 2013).

6. Hypertension: Those who, as of 2013 (WHO), are 18 years over age or older and who have a blood pressure reading of 90 or 140 at the diastolic level.

7. An adult (18 years of age or older) with increased blood glucose must meet one of two criteria: either they are receiving therapy for their raised blood glucose or have a plasma or fasting glucose concentration of more than 126 mg/dl (7 mmol/L).

8. Overweight and Obesity: According to the WHO, an individual who weighs more than 25 kg/m2 is considered overweight, while an individual who weighs more than 30 kg/m2 is deemed obese if they are eighteen years of age or older.(2013).

9. A higher intake of saturated fat (>150 mg/dL) (WHO, 2013)

10. Elevated cholesterol: greater than 5.0 mmol/L (190) (12)

There are numerous factors that can increase a person's risk of developing non-communicable diseases (NCDs). One method divides risk variables into two categories: modifiable and non-modifiable, based on the degree of conditional variation. Genetics, age, gender, and race or ethnicity are risk variables that are unchangeable. Conversely, high blood pressure, obesity, diabetes, tobacco use, and type 2 diabetes were all modifiable risk factors. It's interesting to notice that most parameters relating to gender and age can be changed, despite the fact that they cannot. Alternatively, the non-modifiable components might be classified into one of three groups: (i) Factors related to behavior: smoking, drinking, eating poorly, and not exercising. (ii) Biological factors: obesity, dyslipidemia, hyper-insulinemia, hypertension; and (iii) Sociological factors: intricate webs of interconnected socioeconomic, cultural, and environmental variables [10].

3. Prevalence

A wide range of illnesses, including diabetes, cancer, heart disease, and chronic respiratory conditions, are referred to as "non-communicable diseases" (NCDs). An estimated 38 million deaths worldwide (68% of all fatalities) are attributed to NCDs each year, with 5.87 million of those deaths (60%) taking place in India. More over two thirds of South-East Asian deaths from NCDs occur in India, a nation of 1.3 billion people. Smoking, hypertension, and high glucose levels were the three main risk factors that accounted for the majority of the yearly deaths in this region, according to the 2011 evaluation of NCD status in SEAR [12].

According to WHO projections, noncommunicable diseases (NCDs) would be responsible for over 70% of fatalities worldwide by 2025, with emerging nations bearing the brunt of these deaths (85%). Research suggests that if successful precautionary actions are not created and put into place, 41 million individuals in minimal-resource nations are predicted to pass away from NCDs by 2025. Cardiovascular conditions (CVDs), is responsible for 48% of all deaths in these nations, Type 2 diabetes (3%), and chronic respiratory disorders (12%), are the primary cause of death [13].

According to predictions from the World Health Organization (WHO), 17 million deaths globally in 2005 were attributed to cardiovascular disease (CVD), accounting for about 30% of all fatalities. Approximately 80% of these deaths occurred in nations with moderate to low incomes, such as India. A 2009 International Diabetes Federation (IDF) poll found that 0.50.8 million Indians were living with diabetes. After heart disease, stroke remains the second most typical reason of mortality, with 5.6 million fatal instances reported each year, 40% of which involve individuals under the age of seventy-eight. On the other hand, studies conducted in rural Andhra Pradesh and Kerala estimated incidences as high as 13.2% and 12.5%, respectively, suggesting a marked improvement in the current state of affairs [11]. Non-communicable diseases (NCDs) were more common in women and older respondents (those over 60). The World Health Organization (WHO) estimates that non-communicable diseases (NCDs) cause 41 million deaths year, or 71% of all deaths globally [14] (Figure.1).

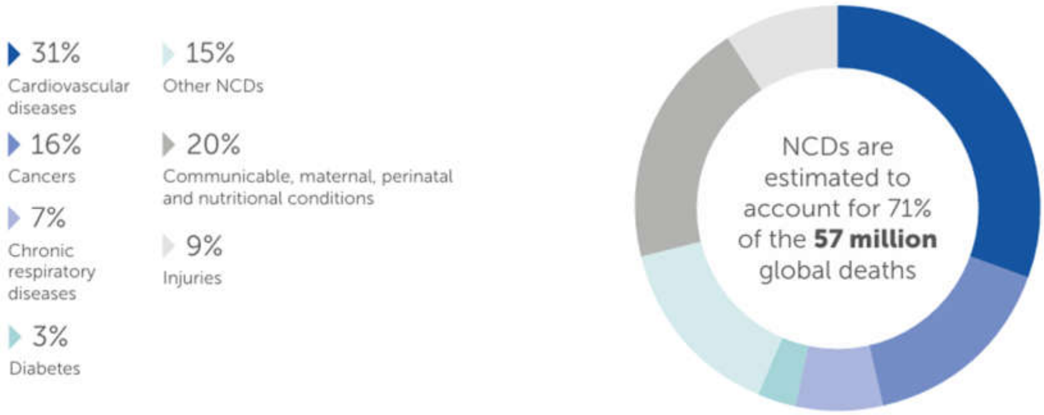

Figure 1: Illustrates the global death rate of NCDs among both sexes [15]

4. Pathogenesis of Non-Communicable Diseases

The majority of common, preventable risk factors that are associated with a higher frequency of noncommunicable diseases are to blame for this increase. The four primary noncommunicable diseases (NCDs) that are directly associated with the four primary behavioral risk factors are diabetes type 2, cancer, cardiovascular disease, and chronic respiratory issues. These four factors are unhealthy westernized foods, harmful alcohol consumption, and physical inactivity. Four major metabolic/physiological problems result from these processes, including raised blood pressure, elevated levels of lipids, raised blood glucose, and overweight/obesity. One major environmental danger element is air pollution [15]. Significant changes in this scenario have been recognized as the onset of oxidative damage (OxS), elevated insulin levels and insulin resistance, latent inflammatory conditions, and immune system dysregulation [16].

4.1. Environmental pollution

Air pollution, a combination of gases that includes particles (PM) and organic pollutants, is one of the effects of urbanization.In a similar vein, an epidemiological investigation (n = 43) conducted in Southern California, USA, suggested that the positive correlation among pollution in the air and fasting glucose levels could be explained by an increase in Coriobacteriaceae and a decrease in Bacteroidaceae.Of them, Coriobacteriaceae is the primary producer in the gut of phenylacetylglutamine, which was recently found to be a biomarker of type 2 diabetes (T2DM) .

4.2. Dietary Habits:

One of the primary variables that directly affects an individual's gut microbiota makeup is their diet. The gut microbiome of both humans and mice experiences a decline in alpha diversity due to the depletion of gut microbial species caused by a Western diet. A few notable resident species, including Prevotella spp., Roseburia spp., and Rumicoccus bromii, have disappeared as a result of this reduction [7].

4.3. Developmental issues:

Research indicates that components of metabolic syndrome may be brought on by an unbalanced dietin combination with early-life exposure to environment pollutants throughout development. Unbalanced nutrition and chemical exposures in the environment during development may, in fact, combine to create the "perfect storm" for obesity by changing the set-point for weight growth and metabolism [17].

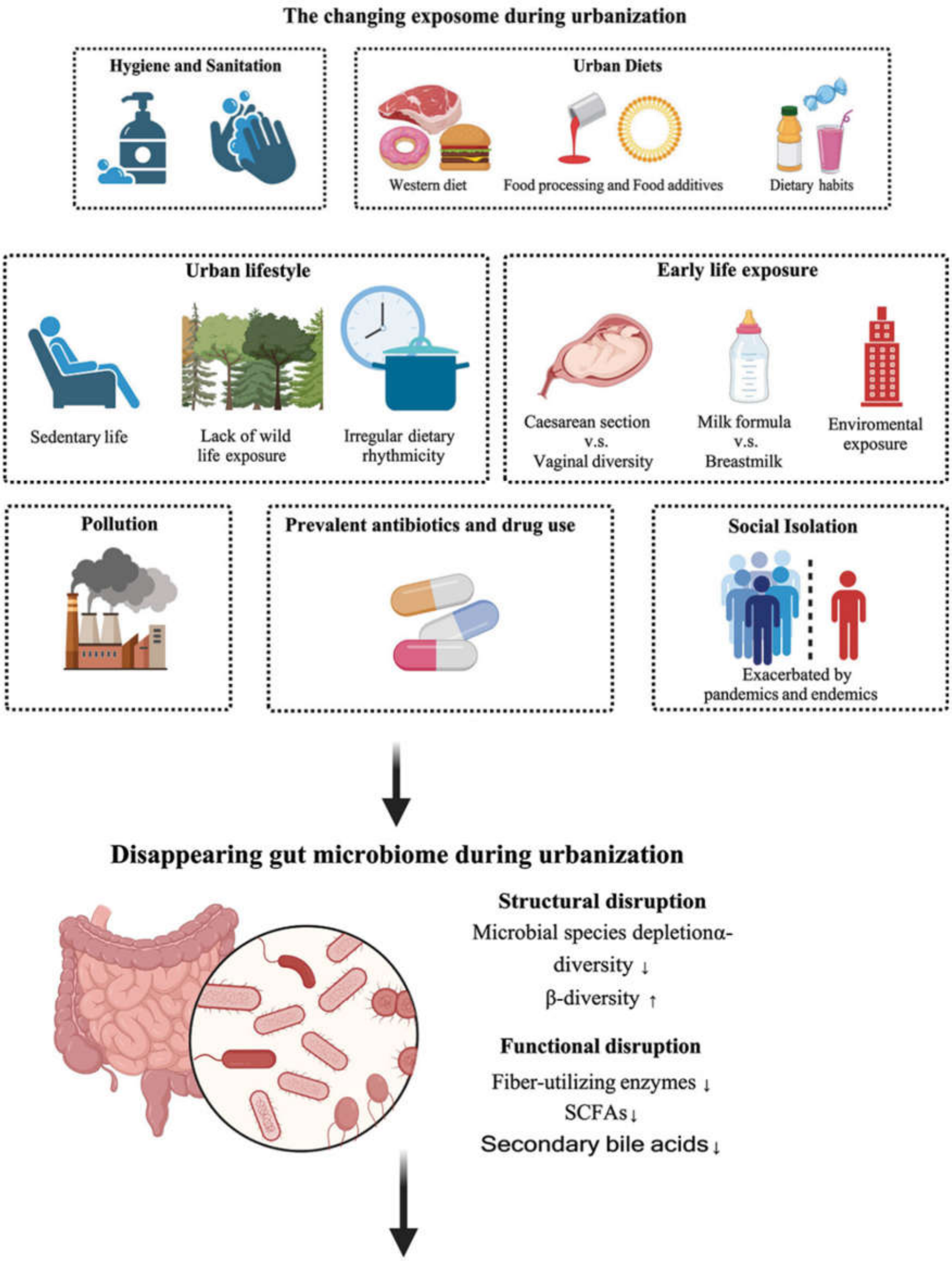

Figure 2: Illustrates the development of NCDs due to urbanization [7]

4.4. Sedentary Lifestyle:

Due to the long workdays found in most urban civilizations, urban dwellers' meals routines are becoming more erratic.By using a circadian clock, the gut microbiota can regulate the major histocompatibility complex epithelial barrier axis in the small intestine's diurnal rhythm and react to the feeding pattern. An irregular diet can throw off rhythms and compromise the functioning of the intestinal epithelial barrier, leading to a significant exacerbation of Crohn's disease.

4.5. Antibiotic Effect:

Because of the widespread use of antibiotics, the amount of beneficial bacteria in human intestines has decreased, resulting in an internal insult to the gut that is the fundamental cause of non-communicable diseases. In addition to metabolic problems, antibiotic-induced gut dysbiosis increases the chances of non-communicable diseases (NCDs) [7] **Figure 2**.

5. Gut Microbiota's Role in Specific NCDs

The majority of individuals agree that genetically modified organisms (GMs) contribute to the spread of non-communicable diseases (NCDs) and that alterations in the gut microbiota may be the root cause of disease [18]. Although not all bacteria are pathogens, from an immunological standpoint, they are seen as pathogenic organisms that cause illness in the host and trigger the immune system to eliminate them. Additionally, they preserve the functioning of the gastrointestinal barrier and prevent pathogenic germs from forming colonies within the host cell [8].

5.1. Diabetes Mellitus:

Diabetes is one of the major reason for illness and mortality worldwide .It has been found that GM can affect inflammation, fatty acid oxidation, intestinal permeability, and glucose metabolism. Genetic modification (GM) has the ability to control the body's glucose metabolism in addition to the impacts of microbes. The first-line treatment for diabetes is metformin which can lessen the absorption of lipopolysaccharide by controlling the makeup of intestinal bacteria, which can improve intestinal barrier function and preserve intestinal integrity [18].

5.2. Obesity:

One of the main underlying causes for several NCDs, including heart disease, is obesity.It is noteworthy that facultative anaerobic Enterobacteriaceae overrun their host in obese individuals exposed to high-fat diets. This shows that the proliferation of TMA-producing Enterobacteriaceae driven by high-fat diets may be involved in the development of obesity-related heart disease [19].

5.3. Cardiovascular Diseases:

It has been demonstrated that metabolites derived from genetically modified organisms (GM) affect the prevalence of cardiovascular disease. These metabolites include extra bile acids and short-chain fatty acids. These metabolites can also directly impact the development of atherosclerotic plaques by impairing endothelial cell function and inducing persistent inflammation. The transmission of atherosclerosis, thrombosis, and hypertension may be facilitated by the gut microbiome [18].

5.4. Liver diseases:

Growing evidence from several models of the aetiology of liver disease points to the GM as the cause of steatosis, inflammatory conditions, and even fibrosis. Hepatic encephalopathy patients had higher levels of potentially harmful Enterobacter sp. and lower levels of bacteria that produce short-chain fatty acids than healthy individuals. The GM plays a key role in regulating the gut-liver-brain axis, and liver disorders can develop more quickly if this relationship is disrupted [18].

5.5. Cancer:

The gut microbiota is important for human health even when dysbiotic bacteria produce an overabundance of toxins.These poisons cause cancer and inflammation.The first germs linked to cancer are thought to be Helicobacter pylori, which produces the protein CagA. This gene causes the intestinal epithelial cell's p53 to be degraded by proteases, interfering with the host's AKT pathway and ultimately leading to gastric cancer [18, 19].

5.6. Stroke and Hypertension:

Hypertension may be mostly caused by the gut flora. The human gut microbiota produces trimethylamine N-oxide (TMAO), which has been connected to microbiota and the risk of stroke [20].

5.7. Polycystic Ovarian Syndrome:

Reputable studies have shown that both PCOS patients and animal models experience microbiome dysbiosis. Considered as the wide range of ecological circumstances (between habitat diversity), beta (β) diversity has been found to fluctuate and α diversity to decrease in PCOS patients, according to multiple research [21].

6. Role of Diet in Gut Microbiome and Management of NCDs

Nutrition has a major impact on the diversity, support, and efficiency of the microbial community in our gut, and varied diets have a major impact on the structure, function, and diversity of the gut microbiome [22].. The different products with salient findings and possible use in NCDs are listed in Table 1.

Eating patterns have a great influence on life expectancy, level of living, and longevity.The gut microbiota is being identified by increasing amounts of research as a secret organ that controls immune activation and general host homeostasis.Due to Western diets, tobacco use, drug use, sedentary behavior, and modern lifestyles, there is a considerable reduction in gut bacteria diversity. Numerous non-communicable diseases have been connected to this decrease (NCDs) [23]. One of the key determinants of gut microbiota structure and one that can change it quickly is diet [24].

6.1. Plant based and mediterranean diet:

Fruits, vegetables, grains, legumes, nuts, seeds, and herbs are all part of plant-based diets. In 2023, Sidhu et al. carried out a comprehensive investigation of the advantages of a plant-based diet in the management of metabolic and autoimmune diseases, as well as the impact of the diet on the composition of the gut microbiota. 583 participants participated in the thorough review.The health status of the participants comprised cardiovascular risk, obesity, rheumatoid arthritis, and general health [25]. The main components of the Mediterranean diet (MD) include nuts, olive oils, and fibre (complex, insoluble, and MAC, mostly found in whole grain products, vegetables, fruit, and legumes). Better MD adherence relative to poorer MD adherence may result in a bigger amount of total SCFAs, a decrease in Escherichia coli levels, an increase in Bifidobacteria abundance, better gut microbiota variety and richness, and a smaller ratio of Firmicutes to Bacteroidetes [26].

6.2. Low carbohydrate diet:

Evolutionarily speaking, consuming less than 40% of energy from carbohydrates would have been the norm and would have prevented hyperglycemia and hyperinsulinemia, which in turn would have prevented cancer. According to scientific research, sugar molecules change the microbiota and cause a modernized microbiome that significantly reduces the diversity of gut bacteria. It is well known that ingesting sugar can promote the growth of tumors and that glucose and glycolysis are the main energy sources used by tumor cells [23].

6.3. Low FODMAP diet:

Lately, there has been an increasing trend toward the complete eradication of all fermenting oligosaccharides, disaccharide, simple sugars, and polyols (FODMAPs) in the diet. For those receiving nutritional therapy for inflammatory bowel disease and irritable bowel syndrome (IBS), this is particularly crucial.Individuals on a low-FODMAPS diet exhibited lower amounts of Bifidobacteria, Propionibacteriaceae, Clostridium cluster IV, and Akkermansia muciniphila than patients on a typical diet [26].

6.4. Ketogenic diet:

A unique kind of low-carb diet known as a ketogenic diet (KD) occurs when the liver produces ketone bodies (often fewer than 50 g/day) when the intake of carbohydrates is drastically decreased. This results in low levels of insulin and slightly elevated cortisol levels. KDs can enhance metabolic processes and guard against cancer and other NCDs by preventing the growth of cancer cells and glycolysis. Numerous methods, such as (i) reducing insulin levels, (ii) raising mitochondrial substrate oxidation, and (iii) having particular anti-oxidative and anti-inflammatory properties, can accomplish this. Furthermore, some research suggests that patients might benefit from these anti-tumor properties [23].

Table 1. Different products with salient findings and possible use in NCDs

Product	Processing methods	Intervention	Dose and duration	Salient findings	Possible use in NCDs
Yoghurt	Fermentation	Randomised Double blind Placebo controlled clinical trail	1g /12 weeks	Increased the amount of sIgA at human mucosal locations and caused dentritic cells to produce more IL-6 and IL-10.	Intestinal Homeostasis [27]
Fermented milk	Fermentati on	In-vitro α-glucosidase activity assays		Inhibited α-glucosidase and the angiotensin absorption enzyme (ACE).	Hypertension and Hyperglycemia [28]
Kefir	Fermentation	Unblinded, crossover, randomised study of 28 overweight persons with asymmetrical symptoms.	300ml/day - 8 weeks	An increase in zonulin levels has a favorable impact on the individuals' mood.	Overweight [29]
Fermented soymilk	Fermentation	In-vivo rat study	10ml/kg of body weight during 90 days by kefir	Reduced LDL by 24-66%, raised HDL by 32%, and raised blood glucose by 36% in rats.	Obesity [30]

Fermented carrot juice	Juice extraction, pasteurization, fermentation	In-vivo study in rice	10ml/kg for 6 weeks	Changed the gut microbiota's composition by controlling the expression of genes linked to rats' glucose metabolism.	Type-2 diabetes [31
Fermented kimchi	Fermentation	Models of colitic carcinoma in mice were initiated by azoxymethane and enhanced by sodium dextran sulfate.	51.g/kg up to weeks	Antioxidative, anti-inflammatory, and antimutagenic properties in colitic carcinoma	Cancer [32]

7. Role of probiotic and prebiotic in gut microbiota modulation:

The microbial activity of bacteria, yeast, mycelial fungus, and their enzymes produces fermented foods, which are foods that are plentiful in nutrients and functional qualities [33]. The International Scientific Association for Probiotics and Prebiotics (ISAPP) provides the definition of fermented food as "foods prepared by the enzymatic conversion of food components and desired microbial growth." Numerous variables, such as the nutritional modification of raw ingredients, the synthesis of bioactive chemicals, the alteration of gut microbiota, and immune system regulation, are responsible for the health advantages of fermented foods [34]. In addition to producing vitamins, minerals, enzymes, and physiologically active peptides, fermentation removes antinutrients from food. Physiologically active peptides have been shown to have antibacterial, antioxidant, antihypertensive, antidiabetic, and anticancer properties [35]. In addition to having health effects similar to those of the healthy gut microbiota, the probiotics from fermented foods have been shown to alter the microbiome of the gut to a beneficial bacterial genome ratio. These effects include competing with pathogens for nutrients and space, maturing the immune system, activating the host immune system and immune cells, and metabolizing lipids, glucose, and bile acids [36].

Fermented foods include beneficial bioactive compounds that foster a symbiotic link between the microbiota and the host, improving the intestinal environment. Acetate, butyrate, propionate, and other SCFAs from fermented foods help the gut's beneficial bacteria phyla grow, inhibit the growth of intestinal pathogens, and regulate several critical metabolic functions [37]. Phenylacetylglutamine (PAGln), a metabolite produced by bacteria, has recently attracted attention due to its role in the onset and progression of cardiovascular and cerebrovascular diseases. The meta-organismal metabolite PAGln is created when the amino acid acetylates its precursor, phenylacetic acid (PAA), which is found in a wide range of foods, including meat, eggs, dairy products, and more [38]. Additionally, probiotics have been shown to reduce the side effects of chemotherapy in cancer patients. Juan et al. (2002) found that probiotic administration prevented any abnormal changes in the gut microbial profile in breast cancer patients undergoing chemotherapy. The trial was double-blind, randomized, and placebo-controlled (2022) [39]. It has been observed that the glucagon-like peptide 1 content in yogurt has anorexigenic properties that successfully prevent obesity [40]. Tiss et al. (2020) reported a 20% reduction in body weight in high-fat-high-fructose-diet (HFFD) rats when they were given fermented soy milk [31]. The course of cardiovascular disease and hypertension can be significantly slowed by fermented foods, such as Japan's Natto, a soybean product fermented by Bacillus subtilis [41]. Consuming fermented dairy products is thought to improve insulin sensitivity, increase glucose tolerance, preserve gut flora, and promote satiety, all of which may help treat type-2 diabetes mellitus [42, 43].

Nano particles play an important role in the digestion and gut microbiota modulation and the study about the interaction between nanometerials and gut microbiota are scarce [44]. The so far studied nano particles in gut microbiota modulation and digestion includes silver nano particles (Ag), copper nano particles (Cu), silica ($SiO2$) nano particles, titanium ($TiO2$) nano particles and zinc (ZnO) nano particles. The usage of nanomaterials in the modulation of gut microbiota resuting positive effects in the study of cancer chemotherapy. The involvement of gut microbiota in the carcinogenecis is revealed recently that it can increase the efficacy of the anticancer therapy. The combination of nanoparticles, nanomaterials and modulation of gut microbiota can lead a new area of research to find specific biomarkers [44].

8. Conclusions

The rapidly changing environment and modern lifestyles are probably to blame for shifts in the range of bacteria present in humans. The body's varied microbial composition can cause inflammation in two separate conditions: obesity and inflammatory bowel illness (IBI).The molecular relationship between gut microbiota, host health, and dietary constraints is still unknown. To fully comprehend the causes and impacts of microbiota-driven NCDs, more human research is needed. These may have a discernible effect on the immune, metabolic, and physiological systems of human health. Deviations from intestinal homeostasis and the gut flora may also have multisystemic effects. The gut microbiota, often known as the microflora, is an essential part of the host defense.They assist in the breakdown of necessary molecules, encourage development and proliferation, help prevent disease and infection, and enhance the environment in the gut—all while maintaining a healthy environment.

Beneficial modifications to the gut microbiota can affect host metabolism, gut barrier transparency, and brain function, all of which can extend life expectancy and postpone the onset of NCDs. It is yet unclear how dietary limitations, gut microbiota, and host health are related molecularly, and further research on humans is needed to fully comprehend the processes and consequences of microbiota-driven NCDs. Certain new discoveries may spur the creation of cutting-edge tactics to control the microbiota and cure or prevent certain illnesses in future. The usage of nano particles and nano materials in the moduation of gut microbiota and their effect also an important area of future research.

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Conflicts of Interest

The authors declare no conflict of interest.

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