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Dietary Modulation of the Gut Microbiota in Chronic Disease Prevention: Current Evidence and Future Directions

Surya Shekhar Sarkar[1], Shibam Khan[2]
Department of Medical Laboratory Technology, Paramedical College Durgapur, Bidhannagar, Durgapur, West Bengal 713212, India.

ABSTRACT

The human stomach and intestines are home to an ever-changing collection of trillions of tiny living things, which are together called the gut microbiota. In the twenty years important studies using many different types of analysis have changed the way we think about these tiny creatures. They are no longer seen as living along with us but instead as very important in how our bodies work how we keep our metabolism balanced and how our immune system works. What we eat is the thing we can change that affects the way the gut microbiota looks and how it functions. Long-term health problems like obesity, type 2 diabetes, heart disease, bowel diseases and cancer are often linked to an imbalance, in the gut microbiota. This imbalance is shown by variety in the types of microbes fewer helpful bacteria and more harmful ones. This essay looks closely at how what we eat affects the gut microbiota. It explores the ways that different diets, types of nutrients like fats and carbohydrates and plant-based compounds change the balance of bacteria in the gut. A big focus is on the chemical products made by these microbes— short-chain fatty acids, TMAO and secondary bile acids—and how they influence health or contribute to disease. The essay reviews clinical studies on specific eating plans such as the Mediterranean diet, high-fiber eating, ketogenic diets and personalized nutrition strategies. These are being tested for their ability to prevent or manage long-term conditions. Finally it points toward what's in microbiome research: moving beyond simply observing connections, to understanding real cause-and-effect relationships.

Keywords: *Gut Microbiota, Dietary Metabolites, and Inflammation: Implications for Metabolic and Neurological Health.*

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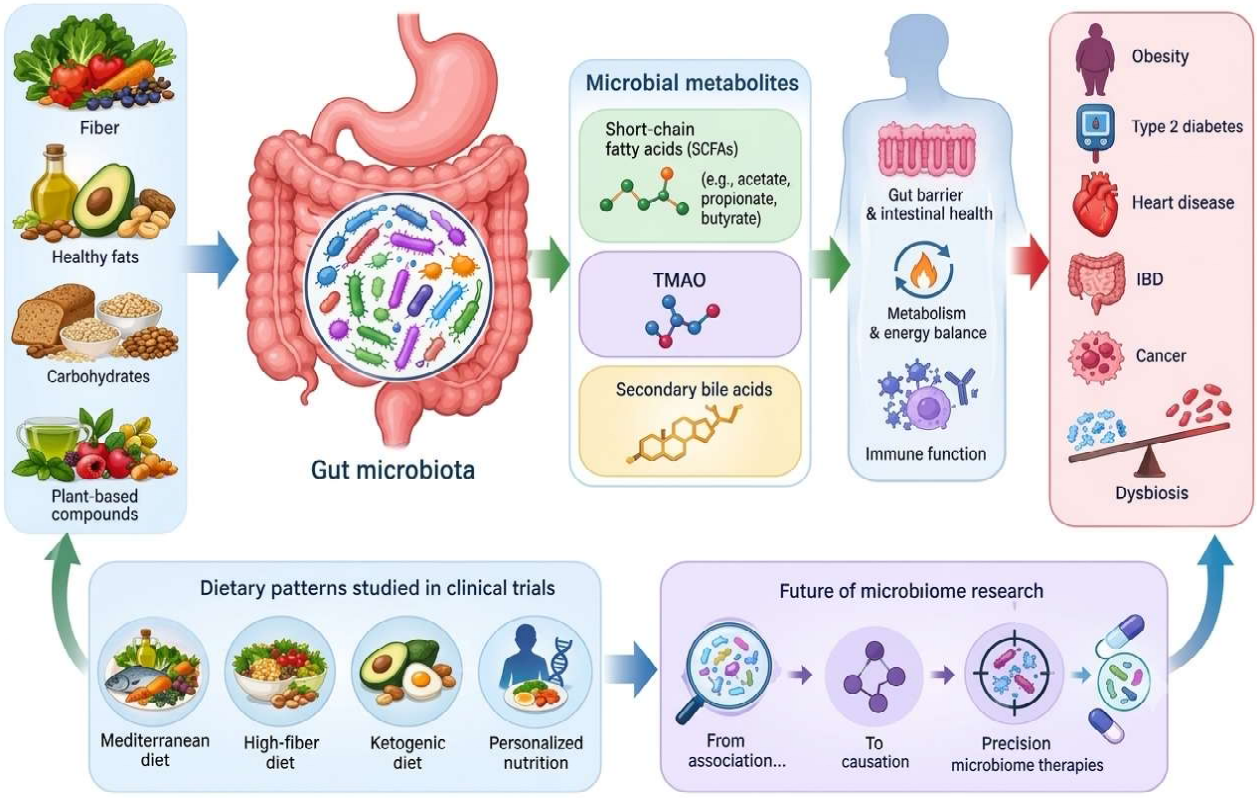

Graphical Abstract

INTRODUCTION

The human stomach and intestines have a collection of tiny living things. This group includes bacteria, some other kinds of microbes, fungi and viruses. Together they are called the gut microbiota. These tiny living things are always working with the food people eat the inside of the gut the bodys defense system and the products they make. Even though the mix of microbes is different for each person, a good and varied group of microbes can help with breaking down food making energy from food keeping the gut walls strong helping the bodys defense system work right and stopping germs from making people sick (Asnicar et al., 2021). In years scientists have found more and more links between changes in the gut microbiota and long-term health problems like being very overweight, diabetes, heart disease, gut inflammation, cancer, in the colon and liver problems. These links have made a lot of people want to find ways to eat that can change the microbes in a way that helps the body stay healthy for a long time. Diet is a powerful and practical factor that shapes the gut microbial ecosystem (Wastyk et al., 2021). We have seen how diet can change quickly. It can change the foods that microbes use to grow and make energy. Foods high in fiber, resistant starch, whole grains, legumes, fruits, vegetables, nuts, seeds and many plant chemicals give microbes the food they need to do work. In contrast diets that have a lot of processed foods, refined carbs, saturated fat and little fiber can lower microbial diversity or shift how microbes produce energy. The link is not only, about finding good or bad bacteria. Microbial effects depend on the community, the foods that are available a person's genes, medicines taken, habits, age and the chemicals that microbes produce (Wang et al., 2021). Dietary modulation means making

changes, to what you eat. The goal is to affect the makeup, variety or how well the gut microbiota works. These changes can include eating fiber eating many different kinds of plants adding fermented foods taking prebiotics or probiotics cutting back on highly processed foods or following eating patterns that are linked to better health. The main scientific question is whether changing the gut bacteria through diet can really stop diseases not just be connected to better health (Beam et al., 2021). Human studies often show connections between what people eat the microbes, in their bodies the substances those microbes produce and the chances of getting sick. Controlled diet experiments have also found that changing what you eat can quickly affect activity and in some cases help reduce inflammation or improve metabolism. Still people react differently and measuring the microbes doesn't always lead to real health improvements. Many studies are small don't last long. Look at indirect signs of disease instead of actual cases. Because of this future research should go beyond just describing the mix of microbes and focus on how they work why they matter, what happens over time and how they affect each person differently (Cronin et al., 2021).

DIET AS A MODULATOR OF GUT MICROBIAL ECOLOGY

Diet is one of the important and changeable factors that affect the makeup, variety and way the gut microbiota works. The human stomach and intestines have a group of tiny living things, including bacteria, archaea, fungi and viruses and the way these microorganisms are made is greatly affected by the food that gets to the colon (Rinninella et al., 2021). So the way people eat can change the way the microbes live by changing what food is available the level of acid in the gut how bile acids work and the way the microbes make chemicals. Term eating habits are very important because if the food people eat stays the same over time it can help some types of microbes grow and stop others from growing (Barber et al., 2021). Fibre from vegetables, fruits, whole grains, beans and nuts is a factor in making the gut microbiome healthy. These fibres are not fully broken down in the intestine and go to the colon, where the microbes break them down. This process makes short-chain fatty acids, like acetate, propionate and butyrate (Roses et al., 2021). These chemicals help the gut lining stay strong help the immune system work right help with energy and keep the gut in shape. Eating a lot of plant foods can also make the microbes more varied and give them more things to work with. On the hand eating a lot of fatty foods, sugary foods, processed items and too much meat can change the gut microbiota in ways that might lead to long-term health problems and bad metabolism. High-fat diets can change the way the body produces bile. This change can help the microbes that're good at dealing with bile. Foods from plants also give the body things like polyphenols, resistant starch and other helpful parts. These parts work with the microbes, in the gut.The microbes can change these things into chemicals that have effects on the body. There is a back and forth between what you eat and how the microbes work (Medawar et al., 2021). Foods that are made by fermenting can also add microbes and things that affect the mix of microbes and the immune system. Changing the gut microbes through what you eat is now seen as an important way that eating healthy can help prevent long-term health problems. Eating a range of foods that have enough fibre, whole grains, beans, fruits, vegetables, nuts and other foods that are not too changed by

processing can help the microbes stay active and strong. People react differently to changes, in what they eat which shows how important it is to understand how each person's diet and microbes work together. This essay will examine the theme of diet and dietary intervention for the management of chronic disease. In particular, this essay will consider six topics relevant to the theme. These are the biological basis of the gut microbiota and its relationship with diet, dietary components and byproducts, cardiometabolic and inflammatory effects, probiotics, fermented foods, personalized approaches, dietary patterns, the state of the science, and public health implications. Gaining an understanding of these topics will allow for identifying how diet is an essential and influential environmental component capable of modulating the microbiota and potentially contributing to prevention approaches (Gutierrez-Diaz et al., 2021).

DIETARY COMPONENTS AND MICROBIOME FUNCTION

Dietary components are factors that shape the gut microbiome. The bioactive compounds that reach the gastrointestinal tract act as food, for the microbes. These compounds influence the variety of microbes the production of metabolites the strength of the barrier function and the immune response. Different dietary components can. Suppress specific microbial groups creating a dynamic link between what we eat and microbial life (Ray et al., 2021). So the quality and variety of components are the keystones of gut microbiome function and can influence the risk of chronic diseases. We have noticed that fibre is one of the things that changes how gut microbe's work. Fibre that comes from fruit, vegetables, beans, whole grains and nuts can sometimes survive digestion in the gut. When fibre gets to the part of the gut it feeds the bacteria there. These bacteria then break fibre down. Make helpful substances. Fibre helps keep the gut healthy and can even affect how our body handles food and fights off sickness. Eating more of these foods that contain fibre is a way to support the gut microbes. We try to include them in my meals every day. They don't always taste the same. They're worth it, for how they help my body. Those fibres are then broken down by bacteria that live in the colon. That break down creates short chain fatty acids (Rodríguez-Daza et al., 2021). Short chain fatty acids that are made in the gut are mostly acetate, propionate and butyrate. These short chain fatty acids give energy to cells. Help keep the gut lining strong. Short chain fatty acids also influence immunity. Help control metabolism. Resistant starch is another food component that encourages microbial fermentation. It can raise the amount of short chain fatty acids. Create a friendly gut environment. Prebiotic carbohydrates, such as oligosaccharides can selectively boost beneficial microbes. In contrast dietary components low in carbs may reduce the food available for microbes and change metabolic activity (Liu et al., 2021). Dietary proteins also shape the gut microbiome. Plant proteins and animal proteins give food to microbes. They can make different kinds of metabolites while fermenting. When dietary proteins do not get digested and reach the colon bacteria can produce substances such, as ammonia, phenolic compounds and branched chain fatty acidsThe effects of these substances depend on the amount's produced and the overall diet. Dietary fats may modify the intestinal microbiota by altering levels of bile acids and their environments within the gut. Foods that are high in fats can influence bile microbes and the ways in which they

function. Unsaturated fats from nuts, seeds and fish can have an effect on the microbes within the gut. The way fats affect the gut depends on the type of the amount that is eaten and the overall pattern of eating. Polyphenols are substances that're present in fruits, vegetables, tea, cocoa and other plant-based foods (Ribeiro et al., 2021). substances are broken down by gut bacteria into active molecules. These changes can have an effect on anti-inflammatory and metabolic processes. Vitamins and minerals can also have a role in how microbes grow and how they interact with the body (Dinsmoor et al., 2021).

DYSBIOSIS AND CHRONIC DISEASE DEVELOPMENT

A healthy gut microbiome usually works with the body to help digestion break down food keep the gut lining strong and support the system. Habits, lifestyle, medicines, infections and the environment can upset this community. Persistent dysbiosis has been linked to diseases such as obesity, type 2 diabetes, heart disease, inflammatory bowel disease and some brain disorders (Albracht-Schulte et al., 2021). Helpful bacteria and their short chain fatty acids, like butyrate help keep the gut lining and tight junctions strong. If microbial diversity drops or metabolite production falls the barrier can become weak. When the gut becomes more permeable, bacterial products and other inflammatory molecules can reach the system possibly causing low grade inflammation. Dysbiosis can also affect health (Las Heras et al., 2022). Changes in communities can alter how the body pulls energy from food how bile acids are processed how glucose is regulated and how fats are managed. Changes in the level of metabolites can affect physiological processes in which feeding, insulin sensitivity and energy balance are controlled. This has been associated with development of obesity and type 2 diabetes and a complex relationships have been reported between the metabolites and characteristics of interest. The associations are further postulated to be bidirectional, with metabolic traits influencing disease risk factors and being influenced by them in turn. Chronic inflammation is another route that connects dysbiosis with disease. (Attaye, et al., 2022). Dysbiosis leads to the disruption of the balance between tolerance and inflammation in the gastrointestinal tract, and the gut microbiota affects the host through the production of specific metabolites from ingested dietary components, which in turn are involved in the regulation of vascular functions and metabolic processes. Similarly changes in makeup and metabolite production have been studied for their impact on brain health via the gut brain axis, which includes immune, metabolic, hormonal and nervous communication between the gut and the brain. Dysbiosis is not a pattern that appears in all diseases. Bacterial changes vary between people and conditions and factors such as age, genes, medicines, exercise and diet shape the microbiome (Kimble et al., 2022). So dysbiosis is still a question whether specific bacterial changes cause disease or result from dysbiosis. Knowing how dysbiosis links, to disease helps us develop microbiome based prevention strategies. Supporting diversity producing metabolites and keeping the gut barrier strong may help keep long term health (He et al.,2022).

DIETARY PATTERNS AND DISEASE PREVENTION

Dietary patterns refer to the combination, variety, quantity and frequency of foods and beverages consumed over time rather than the

effect of a single nutrient or food. Increasing evidence indicates that overall dietary patterns have a role in maintaining health and reducing the risk of chronic diseases (Wu et al., 2022). Diets rich in fruits, vegetables, whole grains, legumes, nuts, seeds and other processed foods provide dietary fibre, vitamins, minerals, polyphenols and other bioactive compounds that support normal physiological functions and may influence the gut microbiota. In particular plant-rich dietary patterns provide substrates for intestinal microorganisms, which can produce beneficial metabolites such as short-chain fatty acids. These metabolites may contribute to intestinal barrier integrity, immune regulation and metabolic health (Howard et al., 2022). Dietary patterns characterized by consumption of fruits, vegetables, whole grains, legumes, fish, nuts and unsaturated fats such as Mediterranean-style dietary patterns have been extensively studied in relation to cardiovascular and metabolic health. Each such pattern can beneficially affect the level of lipids and glucose in the blood, blood pressure, and the state of inflammation. On the other hand, the daily consumption of foods characterized by high processing, the presence of refined carbohydrates, high content of simple sugars, saturated fats, and sodium is associated with adverse metabolic consequences if consumed in large quantities on a regular basis (Bock et al., 2022). Dietary fibre and resistant starch for example can be fermented by bacteria to produce metabolites that influence energy metabolism and immune function. Polyphenol-rich foods may also undergo transformation producing compounds with biological effects. However individual responses to patterns can vary according to genetics, age, lifestyle, medication use, existing health conditions and baseline microbiome composition (Luo et al., 2022). Therefore disease prevention should focus not on a superfood" or nutrient but on maintaining a balanced and diverse dietary pattern over the long term. Adequate hydration, appropriate portion sizes, food variety and regular consumption of processed foods can complement a healthy dietary pattern. Dietary patterns play an important role in body weight regulation, insulin sensitivity, cardiovascular risk profiles and inflammatory processes that may contribute to the prevention of chronic diseases. Overall a diverse nutrient-dense and predominantly plant-based dietary pattern is associated with both host health and a balanced gut microbial ecosystem (Fig. 1). Continued research into diet–microbiome interactions may help develop personalized nutritional strategies, for chronic disease prevention and improve understanding of how long-term dietary habits influence health across different populations (Matson et al., 2022).

MICROBIOTA-DERIVED METABOLITES AND HOST HEALTH

The gut microbiota is a key component of the physiological system, as it ingests food and endogenous metabolites that are further processed into numerous active compounds. The latter are regarded as messengers between gut bacteria and the human body. This communication affects how the body uses energy, how the immune system works how strong the gut lining's other important body functions (Barber et al.,2023). One of the known types of these compounds are short-chain fatty acids or SCFAs. These include acetate, propionate and butyrate. They are mostly made when gut bacteria break down fiber and other tough carbohydrates in the colon. It is crucial to mention that butyrate is an essential energy source for enterocytes that line the colon. In addition, butyrate is critically

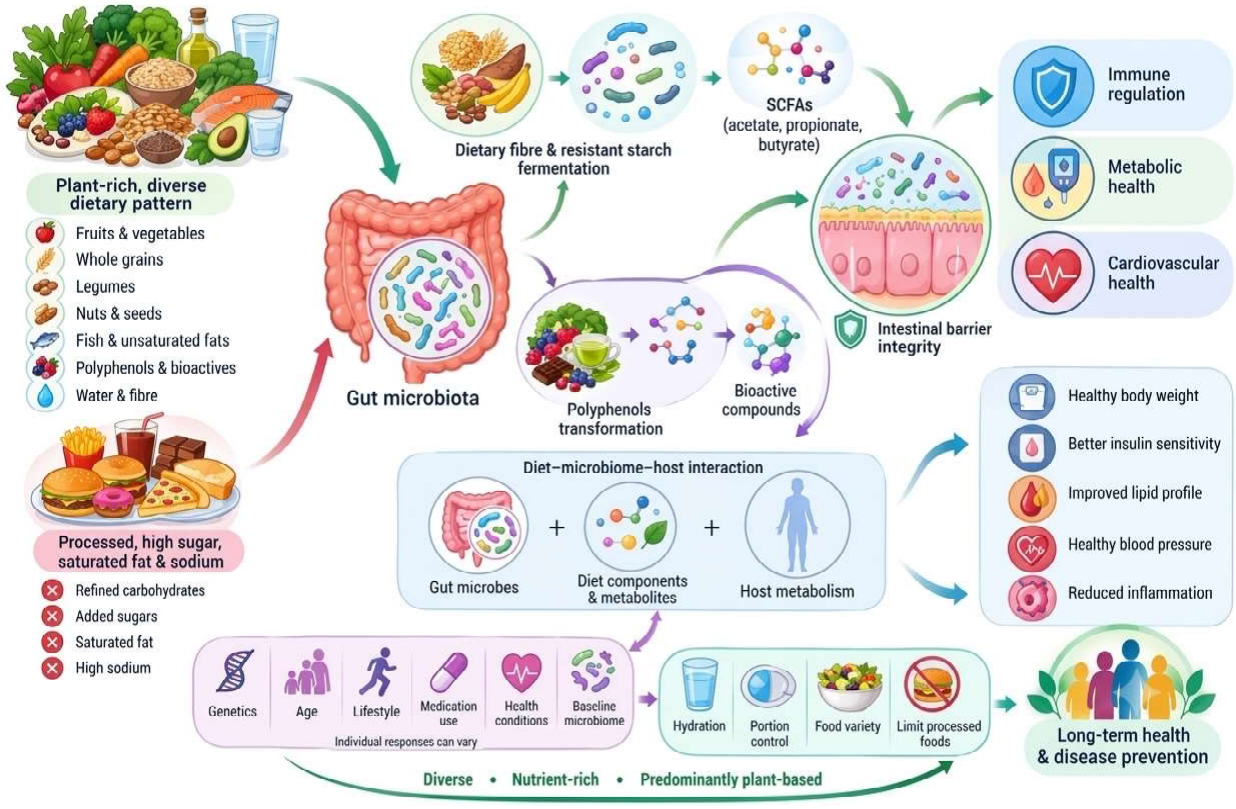

Fig. 1: Diet – Gut Microbiome – Host Interaction in Health and Disease Prevention. This figure illustrates how a diverse, plant-rich diet influences gut microbiota, producing beneficial metabolites that strengthen intestinal integrity and improves immune, metabolic, and cardiovascular health.

implicated in the regulation of immune cell function and metabolic processes. Butyrate is involved in the regulation of inflammatory responses and plays a key role in balancing energy use (Gundogdu et al.,2023). The amount and kinds of these acids are very much dependent upon the type of carbohydrates in the food we eat.The liver produces bile acids which are subsequently modified by gut bacteria to form bile acids. These new bile acids have various effects on the body. They act on receptors that are involved in the regulation of blood sugar levels, lipid metabolism, the immune system and energy metabolism. Changes, in the way gut microbes handle bile acids can affect metabolic and inflammatory responses (Zhang et al.,2023). These are plant-based compounds found in fruits, vegetables, tea, cocoa and other plant foods. The microbes transform them into molecules that may have biological activities. This is yet another way in which the microbiota affects the host through the food. The metabolism of tryptophan is also a pathway by which gut microbes can modify the tryptophan coming from the diet and generate molecules that can bind to the aryl hydrocarbon receptor. These interactions may help control the system in the gut and support the health of the gut lining. The breakdown of acids by gut microbes also produces other compounds such as indole derivatives, phenolic compounds, ammonia and branched-chain fatty acids. What these compounds do depends on how much's present the conditions in the

gut and the overall diet being eaten (Liu et al., 2023). The metabolites made by gut microbes don't just affect the gut. They can influence the system, the endocrine system, metabolism and the nervous system. Through the gut–brain axis these microbial compounds may help the gut and brain talk to each other. They can also get into the bloodstream. Affect organs all over the body. Problems in metabolism have been implicated in obesity, type 2 diabetes, cardiovascular disease, inflammatory conditions and even brain disorders. Diet is an influencing factor on which kind of metabolites are synthesized since different foods provide the microbes with different substrates. Variety in the diet that includes high fiber and plant-based foods supports the creation of metabolites (Fig. 2). The comprehension of these compounds obtained from microbiota provides an understanding of how nutrition is related to health.It also opens up possibilities, for using nutrition to prevent chronic diseases (Carmody et al. , 2023).

EVIDENCE FROM HUMAN AND CLINICAL STUDIES

Evidence from clinical studies increasingly supports a relationship between dietary modulation of the gut microbiota and chronic disease prevention. Observational studies have consistently reported associations between

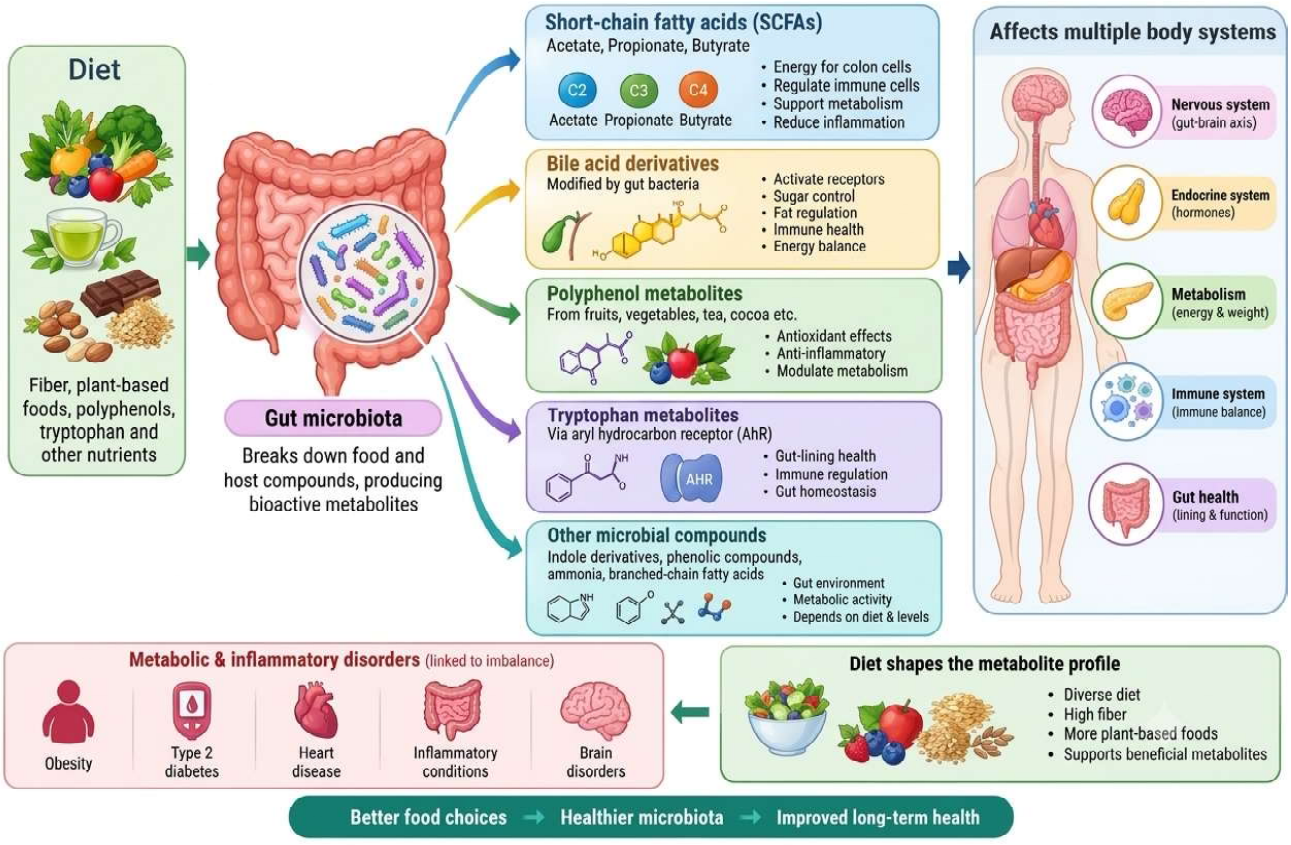

Fig. 2: Gut Microbiota-Derived Metabolites and their impact on Human Health. This figure illustrates how diet influences gut microbiota metabolites, affecting metabolism, immunity, gut health, and inflammation while microbial imbalance contributes to chronic diseases.

patterns, microbial composition, microbial metabolites and health outcomes. Individuals consuming diets in fruits, vegetables, whole grains, legumes, nuts and other fibre-rich foods generally show greater microbial diversity and increased production of short-chain fatty acids (SCFAs) particularly acetate, propionate and butyrate (Van Hul et al.,2023). These metabolites are involved in sustaining intestinal barrier function regulating responses and bolstering metabolic wellbeing; studies of Mediterranean-style patterns are similarly reported to be associated with alterations in gut microbial composition and microbial metabolic activity while also improving several cardiometabolic health indicators. Randomized controlled trials provide evidence for evaluating dietary interventions. Clinical studies that looked at fibre intake, prebiotic foods or whole plant foods have shown that changing what we eat can change the amount and behavior of certain gut microbes (Table 1).

Table 1: Dietary Patterns, Functional Foods, and Personalised Nutrition in Chronic Disease Prevention: Evidence, Mechanisms, and Research Limitations.

Clinical Evidence Area	*Key Findings*	*Relevance to Chronic Disease Prevention*	*Reference*
Fibre-rich dietary patterns	Diets rich in fruits, vegetables, whole grains And nuts are associated with greater gut microbial diversity and increased production of SCFAs such as acetate, propionate and butyrate.	Supports intestinal health, metabolic regulation and protection against chronic inflammation	Kern et al., 2023
Short-chain fatty acids (SCFAs)	Clinical evidence indicates that dietary fibre fermentation by gut microbes increases SCFA production, particularly butyrate.	SCFAs help maintain the intestinal barrier and may contribute to glucose and lipid regulation.	Kern et al., 2023
Mediterranean-Style diet	Mediterranean dietary patterns have been associated with favourable changes in microbial composition and microbial metabolic activity.	May contribute to improved cardio-metabolic health and reduced risk of obesity, diabetes and cardiovascular disease.	Guan et al., 2023
Prebiotic foods	Clinical interventions using pre-biotic-rich foods or substrates can alter the abundance and activity of selected gut micro-organisms.	May improve microbial function and support metabolic and intestinal health.	Mora-Flores et al., 2023
Whole-plant foods	Increased consumption of diverse plant foods can provide different types of dietary fibres and phytochemicals that influence microbial communities.	May promote microbial diversity and beneficial metabolite production, supporting long-term health.	Deehan et al., 2024

Table (*Continued*)

Table (*Continued*)

Clinical Evidence Area	*Key Findings*	*Relevance to Chronic Disease Prevention*	*Reference*
Metabolic outcomes	Some randomized controlled trials report improvements in glucose regulation, lipid profiles, inflammatory markers and other metabolic parameters following dietary intervention.	Suggests that microbiota-targeted dietary changes may complement strategies for preventing metabolic disorders.	Ross et al., 2024
Fermented foods	Some clinical studies indicate that fermented-food consumption may influence microbial diversity and immune-related markers.	Potentially supports immune regulation and may help reduce chronic inflammatory processes.	Khavandegar et al., 2024
Obesity and metabolic disorders	Dietary modification in individuals with obesity or metabolic disorders can alter gut microbial composition and metabolic activity alongside changes in metabolic health.	Provides evidence for using diet-microbiota interactions as a potential component of chronic disease management and prevention.	Duncanson et al., 2024
Individual variability	Responses differ between individuals because of microbiota composition, genetics, medications, age, lifestyle and existing dietary habits.	Highlights the need for personalized or precision nutrition rather than assuming one dietary intervention works equally for everyone.	Sinha et al., 2024
Limitations and future research	Association do not always establish causality; many studies are short-term, and microbiota composition varies considerably between individuals and populations.	Large, longer-term controlled trials are needed to identify consistent and clinically meaningful microbiome-based dietary interventions.	Kong et al., 2024

EMERGING MICROBIOME-TARGETED NUTRITIONAL STRATEGIES

Emerging microbiome-targeted nutritional strategies focus on changing the gut ecosystem through what people eat. These approaches are aimed at health improvement as well as disease prevention. However, in contrast to the belief of calorie restriction and single-nutrient diets, multimodal nutrition considers interactions between nutrients and gut microorganisms and the impact of their metabolic products on the host's health.One of the well-known methods is increasing fiber intake. Fiber comes from grains, beans, vegetables, fruits, nuts and seeds. This kind of fiber feeds the gut microbes during fermentation. The process generates short-chain fatty acids such as acetate, propionate and butyrate. Short-chain fatty acids contribute to the maintenance of the integrity of the gut lining, regulate the immune system and support healthy metabolism. Prebiotics represent another approach.Prebiotics are types of carbohydrates that specific good microbes can use(Farahbod et al. , 2024). They include oligosaccharides and other fermentable carbs.

These fermented foods contain microorganisms and biologically active metabolites that may beneficially affect the gastrointestinal tract environment. Synbiotics differ from prebiotics and probiotics because they are a combination of both, creating a powerful tool that uses the best characteristics of each to improve the well-being of the host. On the other hand, postbiotics are microbial cell products, either metabolites or killed organisms, with a beneficial impact on the human body. Since they don't rely on living bacteria postbiotics may be more stable and easier to control in formulations. Personalized nutrition is becoming more common in research (Vazquez-Cuesta et al., 2024). People have gut microbial makeup due to genetics, lifestyle, metabolism and past eating habits. Because of this the same food can affect individuals differently. Improvement in sequencing of microbiome and metabolites and the use of intelligence can enable tailoring of diet in accordance with an individual's microbiota and metabolic profiles. Additional possibilities include emphasizing diverse dietary sources of polyphenols (e.g., berries, dark chocolate) and manipulating dietary fibers (e.g., resistant starch) and assessing the impact of intestinal microbe metabolism of bile acids and amino acids. Still many of these approaches are still being tested in settings. Their long-term safety and effectiveness need study. Overall these new nutritional strategies offer ways to connect food choices with gut health and disease prevention. Future studies should focus on clinical trials consistent ways of measuring the microbiome longer observation periods and taking into account how much people differ from one another. Then can we know which interventions truly deliver real health benefits (Dimba et al. , 2024).

KNOWLEDGE GAPS AND FUTURE RESEARCH PRIORITIES

Despite a lot of progress in learning how what we eat affects the gut microbiota and the risk of diseases there are still big gaps in what we know. Current research shows that the way people eat the fiber they consume the fermented foods they eat the polyphenols they take in and other active parts of food can change the types of microbes in the gut. People react differently to the same diet (Xu et al., 2024). Things like age, genes, how they live the medicines they take the microbes they already have where they live and their health conditions can all play a role in this difference. A main goal for research now is to find out why peoples microbiota react in ways and to see if certain patterns of microbes can predict if a diet will help or hurt. Another big gap is telling the difference between what's just linked and what actually causes something. Many studies have shown that alteration in the composition of gut microbes was associated with diseases such as obesity, type 2 diabetes, cardiovascular diseases, bowel disease and brain disorders. There is a lack of knowledge concerning how these alterations led to the diseases. Future studies should bring together information about the microbiome with data on metabolites, genes, proteins, the immune system and health measurements to see how changing what we eat affects the chemicals made by microbes and the body processes. Large studies that last a long time and use random assignments are also needed because many current studies have small groups, short periods or different ways of testing diets. Making sure that the way we take samples do sequencing measure what people eat do statistics and share results is the same across studies will make it easier to compare findings

and get results. Future research should also look at if it is safe and if it can be done for a time when using things that affect the gut microbes like prebiotics, probiotics, synbiotics, fermented foods, resistant starch, fiber and individual diets. More focus is needed on people who are not often studied those from low and middle-income countries and different races and places (Laitinen et al., 2025). In addition, the scientists should explore how money, access to food, culture, and the environment affect the relationship between diet and microbes. Another intriguing field of research is personalized nutrition, which uses a person's microbiota and their body's unique mechanisms to improve one's diet. These ideas need good signs to measure tested models and proof that health gets better. Future research should also look at how much it costs. If it can work in real life so that ideas based on the microbiome can become real programs for better health. Overall the next step should be to find out why changes, in microbes happen, who benefits, check if signs are good do long-term studies and turn science into safe, affordable and right ways to prevent long-term diseases (Hindle et al., 2025).

PUBLIC HEALTH IMPLICATIONS AND CONCLUSIONS

Dietary changes that affect the gut microbiota have effects on public health because what people eat is a main thing that can be changed and that can affect the mix of microbes how they work and how the body fights disease. Encouraging people to eat vegetables, fruits, whole grains, beans, fiber, nuts and other foods that are not highly processed can help make the gut environment better and also improve overall nutrition. Public health programs can include gut health in lessons about food activities in schools help for people in communities and efforts to prevent long-term illnesses (Diacova et al., 2025). The advice must come from studies and must consider what people eat in different cultures how much it costs how easy it is to get and whether it can last over time. Interventions that focus on the microbiota like eating fiber taking prebiotics, probiotics, foods that are fermented and custom nutrition might help,. How well they work can vary from person to person and more studies are needed. Public health rules should not say that one microbiota-based approach works for everyone (Aslam et al., 2026). More research is needed to find out how diet changes the microbiota, how the microbes make things and how all of that affects health. Long-term studies and ways to measure the microbiome properly will be important to turn discoveries into help. Overall more proof shows that what people eat and the microbiota are connected and that eating well is part of a plan to stop long-term illnesses. Combining what we know about food, the microbiome, health education and making foods available to everyone can help people stay healthier and lower the number of illnesses, from eating. Future plans should focus on ways to eat that are backed by proof cost fit different cultures and last a long time to help both individuals and groups stay healthier (Lauria et al., 2026).

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