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Full Length Research Paper

Exploring the Roles of Dietary Fibers in Cardiovascular Diseases: A Narrative Review

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Abstract

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Background: Cardiovascular diseases (CVDs) are a group of disorders affecting the heart and blood vessels, and are the leading causes of death globally, taking an estimated 17.9 million lives each year. However, there exist substantial epidemiological evidence indicating a strong relationship between dietary fibre (DF) intake and CVD risk. The review aims to summarize the existing evidence on the relationship between dietary fiber intake and cardiovascular disease (CVD) risk. Methods: This was a narrative review of more than 75 published publications in Nigeria, sub-Saharan Africa, and the rest of the world using search engines including PubMed, Google Scholar, and Mendeley Reference Library. Results: DF consumption may provide direct protection against CVD as well as lower the levels of low-density lipoprotein cholesterol. A recent study linked a higher risk of CVD to the use of ultra-processed foods, which often have low dietary fibre content. Conclusion: This review underline the fact that incorporating dietary fibres into diet is a crucial strategy for reducing the risk and managing the impact of cardiovascular diseases. Regular consumption of high dietary fibre foods, including vegetables, fruits, whole grains, and legumes, is recommended for CVD prevention such as heart failure, atherosclerosis, hypertension etc.

Keywords: Cardiovascular diseases, Dietary fibre, Constipation, Cellulose, GIT Motility.

INTRODUCTION

The majority of metabolic activities in the body, which are a collection of chemical reactions necessary for an organism to survive and carry out basic functions like moving, growing, and thinking, are linked to human health and well-being (Judge & Dodd, 2020). These metabolic activities include the transformation of food, or the conversion of food's energy into energy needed for cellular operations; the breakdown of food into the constituent parts of some proteins, lipids, carbohydrates, and nucleic acids; and the elimination of waste products from the body's metabolism (Judge & Dodd, 2020). Because of this, what we eat has a direct impact on our health. A nutritious diet can help ward against non-communicable diseases (NCDs), like cardiovascular disease (CVD), the world's leading cause of mortality, and malnutrition in all its manifestations. An estimated 17.9 million people die from cardiovascular diseases (CVDs), a set of conditions that affect the heart and blood

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vessels (Kaufman-Shriqui et al., 2022). Sylvester Graham was one of the first persons to promote eating whole grains in the 1830s (Roberfroid et al., 2010). He advocated that a healthy diet should include whole wheat flour and foods high in fibre. However, the significance of dietary fibre remains unidentified. Before a variety of possible therapeutic applications were suggested in the 1970s, the term "dietary fibre" was essentially unknown and was thought to simply refer to bothersome intestinal wastes (Roberfroid et al., 2010). Dietary fibre is "the sum of polysaccharides and lignin not digested by the human gastrointestinal tract," according to Trowell (1978). Dietary fibres were also described by Jimnez-Colmenero et al. (2001) as carbohydrates found in meals that are not broken down by the body's own enzymes in the small intestine. The edible portions of plants or comparable carbohydrates that are resistant to absorption and digestion in the human small intestine and either full or partial fermentation in the large intestine are classified as dietary fibre by American Association of Cereal Chemists (AACC) (Compaore-Sereme et al., 2022).

MATERIAL AND METHODS

A narrative review methodology was employed in this work. Search engines such as PubMed, Google Scholar, and Mendeley Reference Library were utilized to locate and assess over seventy-five published literary works from Nigeria, sub-Saharan Africa, and the rest of the world. The published literature was searched using terms such as "dietary fibres," "impacts of dietary fibres on cardiovascular diseases," "dietary fibres and hypertension," and so on. Furthermore, relevant papers were looked up in the references, and relevant data was appropriately analyzed.

RESULTS

The incidence of cardiovascular disease (CVD) is increasing worldwide and can be mostly attributed to a sedentary lifestyle with excessive sugar and saturated fat intake, as well as a diet poor in fiber, fruits, vegetables, and polyunsaturated fatty acids (PUFAs) (Ignarro et al., 2007). Numerous minerals and phytochemicals included in these foods have been demonstrated to be either solely or partially responsible for the apparent decline in the risk of CVD (Hu & Willett, 2002). Undoubtedly, new opportunities for creating dietary strategies to stop the onset and progression of CVD have been made possible by developments of the mechanisms underlying both healthy dietary fiber and CVDs (Barber et al., 2020). Regarding this, an increasing amount of clinical research and epidemiological methods have shown the fascinating and advantageous effects of dietary fiber consumption on the onset of CVDs (Badimon et al., 2010; Barber et al., 2020; Ignarro et al., 2007).

Characteristic Nature of Dietary Fibre

Dietary fibre is the portion of plants that can be eaten and partially or fully fermented in the large intestine. They come from a variety of sources, including grains, fruits, vegetables, and other sources. They are indigestible substances that are resistant to human digestive enzymes and have no nutritional or energetic value (apart from the tiny amount of energy derived from short chain fatty acids like acetate, propionate, and butyrate produced by the bacterial flora of the colon) Yang et al., 2022). Dietary fibre can be separated into soluble and insoluble types based on their solubility (SDF and IDF, respectively) (Anderson et al., 2009; Holscher, 2017; Slavin, 2013). The SDF is a non-cellulosic polymer that contains some indigestible polymers (such as galactomannan, inulin, gum, arabic gum, and gum). While IDF includes cellulose, lignin and some hemicellulose (Macfarlane & Macfarlane, 2012; Slavin, 2013).

Biochemistry of Dietary Fibre

A group of plant-based cell wall materials, including a variety of molecular structures and a complex mixture of various non-starch polysaccharides (NSPs), such as cellulose, hemicellulose, pectins, gums, β-glucans, polysaccharides of algae (agar and carrageenan), and lignin (polymers of phenylpropane and other plant substances associated with cellulose), are collectively referred to as dietary fibre (DF) (Selvendran et al., 1987; Spiller, 1999). Fruits and vegetables, whole grains and cereals, and dry beans and peas are the finest sources of fibre. Plant foods are the only source of dietary fibre since they include both soluble and insoluble fibres (Rana et al., 2012). DF can be classified into two primary categories according to its characteristics and physiological impacts. There are two kinds of fibre: soluble and insoluble. The capacity of the polysaccharide to disperse in water, as opposed to real chemical solubility, can be used to determine whether a fibre is soluble or insoluble based on its origins (Gemen et al., 2010). Oats, barley, fruits, vegetables, and beans all include soluble fibres, which are dissolved in water and include pectin and gum. Fibres that are insoluble in water include cellulose, hemicellulose, and lignin (Mudgil, 2017). Whole grains, wheat bran, and vegetables are among the foods that contain insoluble fibres. After absorbing water, insoluble fibre increases the volume of the intestine, which promotes healthy intestinal function (Compaore-Sereme et al., 2022).

Phenylpropane polymers and pectin substances are some of the significant dietary fibers. Phenylpropane polymers are mostly found in plant cell walls and are present in most plant structures in combination with cellulose. Comprising 10,000–15,000 glucose molecules

joined by a 1–4 glycosidic bond, it is a linear polymer (Holland et al., 2020; Williams et al., 2017). The cellulose molecules' numerous polar hydroxyl groups enable them to connect with other molecules to generate fibres that are robust structurally and resistant to chemical degradation (Slavin, 2013; Williams et al., 2017). Hemicelluloses are more significant non-cellulosic polysaccharides (NCPs), which are polysaccharides found in cell walls that are soluble in aqueous alkali (Anderson et al., 2009; Holland et al., 2020; Xue et al., 2021). They differ from cellulose in that they have fewer than 200 sugar residues, and their backbones are β-1,4-linked pyranoside sugars (Merenkova et al., 2020; Moyegbone et al., 2023; Yang et al., 2022). The primary monomeric sugar residue is used to categorize the hemicelluloses into different groups (McPherson, 1982). Pectin substances are another significant class of complex, non-cellulosic polysaccharides, the main component of which is D-galacturonic acid. An unbranched chain of axial-axialα-(1-4)-linked D-galacturonic acid units makes up the core structure of pectin. Due to its high water solubility, colonic bacteria virtually entirely digest pectin (Riccioni et al., 2012). DFs' physical properties are determined by their chemical structures and chain conformations, which may have a significant impact on how they react (Compaore-Sereme et al., 2022; Selvendran et al., 1987). The solubility in water, hydration qualities, bulk owing to non-digestibility, rheological qualities, ability to be fermented by gut bacteria, surface area features, and the capacity to absorb bile acids are some of the most significant physical attributes of DF (Guillon & Champ, 2000; Karim et al., 2023).

Dietary Fibre and Physiological Properties

The physiological characteristics of dietary fibres can also be used as classifiers (Mogilny et al., 2013). These could include fibres that prevent the stomach from emptying (like guar), help to quicken and elevate the sensation of saturation (like pectins), slow down the absorption of carbohydrates (like guar and pectin), block estrogen receptors (like dietary fibres of cereals), retain water in the large intestine lumen (like fibres of wheat and legumes), stimulate the large intestine's motor function (like cellulose and collagen), increase the mass of the large intestine's microflora (like fibres of cabbage), absorb bile acids and cholesterol (like guar, cellulose, and pectin), and have an antioxidant effect (like citrus fibre and oat fibre) (Merenkova et al., 2020). More significant revisions have recently been made to the definition of DF in light of the growing understanding of the role that oligosaccharides and resistant starch play in "fibre" activity (Topping et al., 2003). It was previously believed that the human small intestine digested all of the dietary starch found in cooked foods (Bojarczuk et al., 2022). It is now evident, however, that this is untrue and that a significant portion of ingested starch—resistant starch—actually makes its way past the small intestine and into the colon of healthy individuals (Bojarczuk et al., 2022). Some of the health benefits linked to carbohydrates may be mediated by the metabolic end products that are produced when the bacteria in the large intestine ferments the NSPs and resistant starch (Bojarczuk et al., 2022; Compaore-Sereme et al., 2022). Furthermore, other non-digested carbohydrates and undigested protein, or resistant protein, also contribute to large bowel fermentation (Riccioni et al., 2012).

Metabolism of Dietary Fiber in Human Body

Dietary fiber is composed of non-digestible carbohydrates and lignin that are intrinsic and intact in plants (Slavin, 2013). It is categorized into soluble and insoluble fiber (Table 1), both of which play significant roles in human health. Human enzymes cannot digest dietary fiber; instead, it reaches the colon relatively intact (Puhlmann & de Vos, 2022). Here, it undergoes fermentation by the gut microbiota, producing short-chain fatty acids (SCFAs) such as acetate, propionate, and butyrate, along with gases like hydrogen, methane, and carbon dioxide (Rios-Covian et al., 2016). The SCFAs produced during fermentation have various health benefits. Butyrate, for example, serves as the primary energy source for colonocytes and has anti-inflammatory properties (Koh et al., 2016). Acetate and propionate, on the other hand, are involved in lipid metabolism and gluconeogenesis in the liver (Macfarlane & Macfarlane, 2012). Dietary fiber plays a crucial role in maintaining gut health by promoting the growth of beneficial bacteria such as Bifidobacteria and Lactobacilli. This helps in outcompeting pathogenic bacteria and maintaining gut homeostasis (Roberfroid et al., 2010).

Potential Drawbacks of High Fiber Intake

Increased dietary fiber consumption is linked to better glycemic management, decreased serum triglyceride levels, and a decreased risk of Crohn's disease and colorectal adenoma (Ananthakrishnan et al., 2013; Attaye et al., 2022; Ben et al., 2014; Lemons, 2024). Although insoluble fibers like cellulose are minimally digested by gut microorganisms, they are key bulking agents and help in bowel movements (Karim et al., 2023; Lemons, 2024). The gut microbiota's primary and secondary degraders thoroughly break down soluble fibers like inulin, pectin, and guar gum to generate gasses and short-chain fatty acids (SCFAs) (Brown et al., 1999; Karim et al., 2023; Lemons, 2024; Martinez et al., 2021). These short-chain fatty acids (SCFAs), which function as a nutrition source and signaling molecules in

Table 1: Types and Food sources of dietary fibre.

Classification	Description and Examples	Sources	Types of Dietary Fiber	Basic Functions
Soluble Dietary Fiber	Dissolves in water to form a gel-like substance. It is found in various plant-based foods such as oats, barley, fruits, vegetables, and legumes (Mudgil, 2017)	• Oats and Barley • Fruits: Apples, citrus fruits, and berries • Legumes: Beans, lentils, and peas. • Vegetables: Carrots, Brussels sprouts, and sweet potatoes. • Nuts and Seeds: Flaxseeds and chia seeds. (Compaore-Sereme et al., 2022)	**Pectins-** found in fruits like apples, citrus fruits and berries	Soften stool and ease its passage, helping to prevent constipation (Anderson et al., 2009)
			Beta-glucans- present in oats and barley	cholesterol-lowering effects and ability to improve immune function (El Khoury et al., 2012)
			Gums- include guar gum and locust bean gum	Used as food additives to thicken and stabilize products as well as improving glycemic control (Slavin, 2013)
			Inulin- found in foods like chicory root, garlic, and onions	Inulin acts as a prebiotic, promoting the growth of beneficial gut bacteria (Holscher, 2017)
Insoluble Dietary Fiber	It is a type of fiber that does not dissolve in water. It is found in whole grains, vegetables, nuts, seeds, and the skins of fruits.	• Whole Grains: Wheat bran, brown rice, and whole wheat products. • Vegetables: Carrots, cauliflower, green beans, and potatoes. • Nuts and Seeds: Almonds, walnuts, flaxseeds, and chia seeds. • Fruits: Apples (with skin), berries, and pears. (Compaore-Sereme et al., 2022)	**Cellulose**- found in high amounts in vegetables, fruits, and whole grains	It provides bulk to the stool, helps maintain regular bowel movements and reduces the risk of developing hemorrhoids and diverticular disease (Anderson et al., 2009)
			Hemicellulose- found in whole grains and bran	It contribute to stool bulk and facilitate bowel regularity (Slavin, 2013)
			Lignin- abundant in seeds, nuts, and the skins of fruits and vegetables	It helps move waste through the digestive tract (Macfarlane & Macfarlane, 2012)

the digestive system and throughout the body, are frequently linked to the ability of dietary fiber to ameliorate disease (Lemons, 2024). The primary negative effects of excessive fiber consumption that have been documented include discomfort, constipation, bloating, stomach pain, and gas due to the microbial fermentative process (Lemons, 2024). Many research have shown that increased dietary fiber consumption is essential for treating and controlling firm stools in people with constipation (Abdalla et al., 2024; Krishnamurthy et al., 2012; Salmean et al., 2013), despite a recent study suggesting that susceptible mice who consume excessive amounts of fiber are more likely to develop colorectal cancer (CRC) (Yang et al., 2024). However, the unintended consequence of consuming fiber and the fermentation that follows is the generation of gas. This gas is generally malodorous, which can lead to many people experiencing uncomfortable bloating and flatulence (Eswaran et al., 2013).

In Figure 1, unlike other macronutrients, dietary fiber is not digested by enzymes in the stomach. Instead, it performs several functions that contribute to digestive health. Soluble fiber forms a gel-like substance in the presence of water, which can slow gastric emptying. This delay prolongs the sensation of fullness and can aid in weight management (Slavin, 2013). By increasing the viscosity of the stomach contents, soluble fiber extends the time nutrients are in the stomach, enhancing satiety signals sent to the brain (Juvonen et al., 2009). Insoluble fiber, on the other hand, adds bulk to the stomach contents without forming a gel. This bulk can help stimulate stomach distension, contributing further to the feeling of fullness and aiding in mechanical digestion (Jenkins et al., 2000). Although most fermentation occurs in the colon, some soluble fibers may begin to be fermented by stomach bacteria, producing beneficial metabolites in small amounts. These metabolites can have minor, but positive effects on the stomach lining and overall gut health (Holscher, 2017). While the majority of fiber metabolism occurs in the large intestine, the small intestine also engages with dietary fiber, influencing nutrient absorption and gut health (Beane et al., 2021). Soluble fibers, such as beta-glucan and pectin, form viscous gels when mixed with water. This viscosity slows the transit of chyme through the small intestine, which can delay the absorption of glucose and lipids. This results in a more gradual increase in blood glucose levels, which is beneficial for glycemic control (Slavin, 2013). Both soluble and insoluble fibers can bind to minerals such as calcium, magnesium, iron, and zinc, potentially reducing their absorption. However, this effect varies depending on the type of fiber and the overall diet composition (Anderson et al., 2009). Some soluble fibers, such as inulin and oligofructose, may enhance the gut barrier function by promoting the growth of beneficial gut bacteria even in the small intestine (Martinez et al., 2021; Slavin, 2013). These bacteria produce metabolites that can strengthen the intestinal lining and support immune function (Slavin, 2013). Although most fermentation occurs in the large intestine, some fermentation of soluble fibers can begin in the distal small intestine. This partial fermentation produces short-chain fatty acids (SCFAs) and gases, which can have local beneficial effects on the gut mucosa and immune system (Holscher, 2017). The large intestine, or colon, is the primary site for the metabolism of dietary fiber. Here, the undigested fibers undergo fermentation by the gut microbiota, leading to the production of various metabolites that play essential roles in maintaining gut health and overall well-being (Brownlee, 2011). Dietary fibers, both soluble and insoluble, reach the large intestine largely intact. In the colon, these fibers are fermented by a diverse population of anaerobic bacteria, including Bacteroides, Firmicutes, and Actinobacteria (Flint et al., 2012). This fermentation process produces short-chain fatty acids (SCFAs) such as acetate, propionate, and butyrate, as well as gases like hydrogen, methane, and carbon dioxide (Rios-Covian et al., 2016). Butyrate is the preferred energy source for colonocytes, the cells lining the colon. It helps maintain the integrity of the gut barrier and supports overall gut health (Bergman, 1990). Butyrate also has anti-inflammatory properties, which can help reduce the risk of inflammatory bowel diseases and colorectal cancer (Canani et al., 2011). Acetate and propionate are absorbed into the bloodstream and transported to the liver, where they play roles in lipid metabolism and gluconeogenesis, respectively (Macfarlane & Macfarlane, 2012). The fermentation of dietary fiber in the large intestine is associated with numerous health benefits, including improved gut health, enhanced immune function, reduced inflammation, and better metabolic regulation (Brownlee, 2011; Capuano, 2017). These effects collectively contribute to a lower risk of chronic diseases such as obesity, type 2 diabetes, and cardiovascular diseases (Slavin, 2013). Not all dietary fiber is fermented by gut microbiota. The unfermented fibers that reach the distal colon are eventually excreted, along with the metabolic by-products of partially fermented fibers (Macfarlane & Macfarlane, 2012). Insoluble fibers, such as cellulose, hemicellulose, and lignin, are particularly resistant to fermentation (Compaore-Sereme et al., 2022; Mudgil, 2017). These fibers add bulk to the stool and help maintain regular bowel movements (Slavin, 2013). One of the key roles of dietary fiber in excretion is its ability to retain water. Insoluble fibers absorb water as they pass through the digestive system, increasing stool bulk and promoting peristalsis, the wave-like contractions that move stool through the colon (Anderson et al., 2009). This helps prevent constipation and promotes regularity.

DISCUSSION

Dietary Fibre and Cardiovascular Disease

It is crucial to investigate whether dietary fibres' plays a positive effects on insulin sensitivity, appetite control, body composition, and the diversity and viability of the gut microbiota also extend to broader rates of cardiovascular disease (CVD). Although regular use of DF has long been linked to a lower risk of CVD, it is only recently that there has been speculation that DF consumption may provide direct protection against CVD (Riccioni et al., 2012). Increased consumption of DF may be associated with lower levels of low-density lipoprotein cholesterol (LDL-C) and better plasma lipid profiles, according to experimental results obtained from both humans and animals (Riccioni et al., 2012). However, results from a more recent study have linked a higher risk

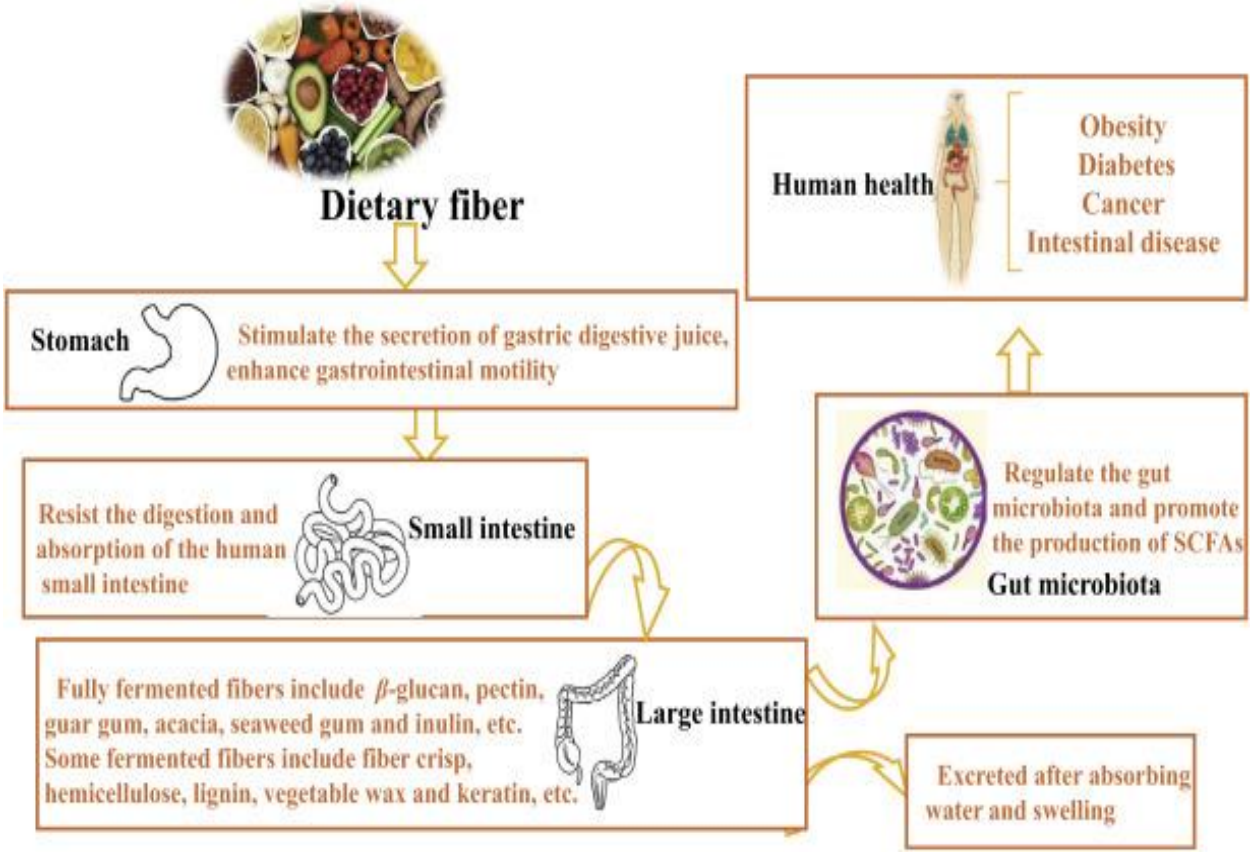

Figure 1. Metabolism of DF in human body and disease prevention (H. Yang et al., 2022).

of CVD to the use of ultra-processed foods, which often have low dietary fibre content. Srour and associates presented findings from the "NutriNet-Santé cohort," a sizable prospective population-based study conducted in France that included over 105,000 adult participants who repeatedly recorded their 24-hour food intake (Barber et al., 2020). Eating ultra-processed food was linked to a greater risk of cerebrovascular disease and all CVDs over a median follow-up of 5.2 years. The benefits of dietary fiber from a range of food sources in lowering the risk of cardiovascular illnesses have been documented by numerous researchers over the past three decades (Buil-Cosiales et al., 2014; Harris & Kris-Etherton, 2010; Mirmiran et al., 2016; Reynolds et al., 2019; Ros, 2009). Additionally, betaine, choline, inositol, methionine, and folates are methyl donors and lipotropes that are abundant in whole-grain wheat which may be important for DNA methylation, hepatic and/or cardiovascular protection, and lipid metabolism (Craig, 2004; Pesqueda-Cendejas et al., 2023).

Dietary Fibre and Coronary Heart Disease (CHD)

According to Okrainec et al. (2004), coronary heart disease is the primary cause of cardiovascular mortality globally, accounting for almost 4.5 million deaths in developing nations. Atherosclerotic plaque, which is typically made of fatty materials, deposits in the heart's arteries and reduces blood flow to the cardiac muscle, resulting in congestive heart failure (CHD) (Mendis et al., 2011). Fat deposits can accumulate and thicken over time on the artery walls (Luca et al., 2023; Valeria et al., 2011). Globally, dietary fiber intake and cardiovascular disease have been the subject of several cohort studies (Akbaraly et al., 2011; Bazzano, 2008; Crowe et al., 2012; Pietinen et al., 1996; Streppel et al., 2005). According to these researches, dietary fiber has a preventive effect on heart disease risk. Foods high in soluble fiber, such as beans, oats, and some fruits, can lower blood levels of LDL (low-density lipoprotein) and total cholesterol (Bazzano, 2008; Brown et al., 1999). It accomplishes this by attaching itself to cholesterol in the gastrointestinal tract and blocking its absorption, hence lowering blood cholesterol levels. Pereira et al. (2004), for example, conducted a meta-analysis of ten distinct cohort studies with follow-up ranging from six to ten years; with a Relative Risk (RR) of 0.84 (95% CI, 0.70–0.99), they found an inverse connection between dietary fiber consumption and the risk of cardiovascular disease. However, a daily increase in fiber intake of 10 grams was

not statistically significant. A meta-analysis study conducted in 2013 by Threapleton and colleagues evaluated the dose–response connection between dietary fiber consumption and coronary heart disease risk. They found that RR = 0.91 (CI 0.87 to 0.94) represented the pooled beneficial impact for every 7 g/day increase in fiber intake. Higher fibre dosages produced less dependable outcomes and had a wider confidence interval around the mean. Thus, it can be concluded from the data that there is an inverse link between the development of CHD and fibre intake; however, moderation rather than excess consumption of fibre is advised (Threapleton et al., 2013).

Dietary Fibre with Stroke and Heart Attack (Myocardial Infarction)

Since these cardiovascular disorders account for roughly 25% and 16.5% of cases of mortality from cardiovascular and cerebrovascular diseases, respectively, stroke and myocardial infarction (MI) are significant public health concerns (Lackland et al., 2014). Stroke and MI alone are potentially fatal illnesses that cause over 800,000 fatalities a year in the United States (Cooper et al., 2022). A stroke is the brain's version of a heart attack, a potentially fatal medical illness that arises when blood flow to a portion of the brain is interrupted (Hui et al., 2024). This may occur as a result of cerebral haemorrhage or clogged blood arteries. A myocardial infarction, also referred to as a "heart attack," is a condition in which there is insufficient or no blood flow to a section of the myocardium (Ojha & Dhamoon, 2023). MI can be "silent," going unnoticed, or it can be a catastrophic occurrence that results in hemodynamic decline and unexpected death (Karunarathna et al., 2020; Thygesen et al., 2007). A cross-sectional study of NHANES 2011–2018 on dietary fiber intake and myocardial infarction and stroke events in US adults was conducted by Dong & Yang in 2022. The weighted prevalence of non-fatal cardiovascular/cerebrovascular events among the 8,872 patients involved in their study was reported to be 5.36%, and it was found to decrease with increasing dietary fiber consumption (Dong & Yang, 2022). In the group with the highest fiber consumption, the prevalence of MI and stroke was 4.25%. On the other hand, stroke and MI progressively climbed from 5.45% to 6.50% as dietary fiber consumption declined. They continued by saying that even though the participant's dietary fiber intake was far below the recommended level, the multivariate logistic regression analysis, smooth curve fitting, and weighted generalized additive model all showed a stable negative association between elevated dietary fiber intake and nonfatal cardiovascular/cerebrovascular events. The Dong & Yang (2022) study's subgroup analysis also showed that, even when the subgroup was divided into categories based on hypertension, diabetes, BMI, and hypercholesterolemia, the negative correlation between fiber consumption, stroke, and MI remained constant. Furthermore, this association was independent of sex, age, race, BMI, smoking status, intense physical activity, diabetes, hypertension, hypercholesterolemia, and sleeping disorders, suggesting that the negative correlation between fiber intake and MI and stroke may be applicable in a variety of population contexts (Dong & Yang, 2022).

Heart attacks and coronary artery disease are intimately associated, and soluble fiber-rich diets have been shown to lower plasma cholesterol in both humans and animals (Bazzano, 2008; Brown et al., 1999; Valeria et al., 2011). In one population investigation, there was a statistically significant negative correlation between the consumption of viscous (soluble) fiber and carotid artery atherogenesis, despite the fact that average fiber intakes were not very high (Truswell, 2002; Wu et al., 2003).

Dietary Fiber and Systemic Hypertension

When blood vessel pressure is excessively high (140/90 mmHg or more), it is known as hypertension (Sun et al., 2018; WHO, 2023). Although frequent, if left untreated, it can become dangerous. An approximate of 1.28 billion persons globally, aged 30-79, suffer with hypertension; the majority, or two-thirds, reside in low- and middle-income nations (WHO, 2023). It is possible for someone with high blood pressure to have no symptoms at all; 46% of individuals with hypertension are thought to be ignorant of the illness until their blood pressure is measured. Unhealthy diets (a diet high in saturated and trans-fats, excessive salt consumption, and insufficient intake of fruits and vegetables) are one modifiable risk factor for hypertension. Thus, in hypertension individuals, increased dietary fiber consumption significantly improved blood pressure and 24-hour ambulatory blood pressure (Xue et al., 2021). Sun et al. (2018) conducted an investigation of the relationship between dietary fiber intake and hypertension in 18,433 adult U.S. citizens. The respondents' age, race, educational attainment, gender, body mass index (BMI), family income, smoking status, and total daily energy consumption were taken into account, dose-response analysis of their data showed a nonlinear trend in the incidence of hypertension with total fiber intake (Sun et al., 2018). They also found that among adults in the United States, consumption of total, cereal, and vegetable fiber—but not fruit fiber—was linked to a lower risk of hypertension (Sun et al., 2018). A randomized controlled experiment on the impact of dietary fiber (oat bran) supplementation on blood pressure in patients with essential hypertension was recently conducted by Xue et al. (2021). The DF group received one bag of oat bran (30 g/d) supplementation, which contained 8.9 g of DF.

Following the intervention, the DF group's diastolic and systolic blood pressures were both lower than those of the control group. The DF group experienced a significant decrease in the use of antihypertensive medications, as well as notable alterations in Bifidobacterium and Spirillum. They came to the conclusion that taking more DF (oat bran) supplement enhanced blood pressure, decreased the need for antihypertensive drugs, and balanced the gut microbiota (Xue et al., 2021).

Dietary Fiber and Heart Failure

Congestive heart failure, or CHF, is another name for heart failure that results from a heart's inability to fill with and pump blood efficiently enough to meet the body's needs (Malik et al., 2023). Because of this, blood frequently backs up and fluid accumulates in the legs and lungs. This accumulation of fluid can lead to dyspnea, edema in the legs and feet, and extreme fatigue, which can lower one's ability to exercise and lower one's quality of life (Kerley, 2019). A plant-based diet high in nitrate, micronutrients, antioxidants (Moyegbone et al., 2023), and fiber and low in sodium (Na), trans fat, and saturated fat may reduce the incidence and severity of heart failure (HF) (Kerley, 2019). Consumption of whole grains, fruits, vegetables, and chocolate was inversely correlated with the incidence and severity of HF. Salehi-Abargouei et al. conducted a systematic review and meta-analysis of observational prospective studies involving over 144,000 participants. They found that while a Dietary Approaches to Stop Hypertension (DASH)-style diet high in dietary fiber was linked to a considerable decrease in the incidence of CVD, heart failure was the condition with the highest risk reduction (Salehi-Abargouei et al., 2013).

Dietary Fibre and Peripheral Artery Disease (PAD)

A type of cardiovascular disease known as peripheral arterial disease is characterized by abnormal constriction of arteries other than those supplying the heart and brain due to an accumulation of fatty deposits in the arteries (Zemaitis et al., 2023). This indicates that the arteries, which are the blood channels that transport oxygen-rich blood from the heart to various regions of the body, are constricted or obstructed (Mercadante & Raja, 2023). Although PAD can occur in any blood vessel, it is more common in the legs than the arms, which limits the amount of blood that can reach the muscles in the legs (Creager & Loscalzo, 2018). There is evidence now available indicating the influence of nutrition on the onset, course, and consequences of PAD (Adegbola et al., 2022; Delaney et al., 2019). Adegbola et al. included 82 studies on the prevention of PAD through dietary intake, comprising of cross-sectional, observational, and randomized controlled trials (RCTs) (Adegbola et al., 2022). Their results showed that while nuts, polyunsaturated fat, and the high-fiber Mediterranean diet are linked to a lower incidence of PAD, cholesterol and saturated fat, processed meat were linked to higher rates of cardiovascular diseases in PAD patients (Adegbola et al., 2022). This results attest to the target population's benefit from dietary fiber consumption. Dietary fiber most likely lowers plasma cholesterol to have this beneficial effect. The presence of additional phytochemical substances in soluble fiber-rich foods have been shown to affect inflammation, oxidation, insulin resistance, and cholesterol metabolism (Riccioni et al., 2012). Reducing the prevalence of PAD may benefit from the integration of nutritional therapy, which includes DF intake as the main preventive strategy (Delaney et al., 2019). Promoting a good diet and nutrition may undoubtedly increase endothelial cell function, decrease oxidative stress, increase blood viscosity, and improve erythrocyte deformability (Agege et al., 2023; Moyegbone et al., 2020).

CONCLUSION

This narrative review demonstrate that eating dietary fiber-rich foods, such as wholegrains, cereals, fruits, and vegetables, protects against cardiovascular diseases (CVDs). Although further research is needed to determine the precise mechanism, the risk of CVD is inversely correlated with dietary fiber intake. Furthermore, whereas insoluble fibers have continuously been linked to decreased incidence rates of CVD, numerous well-controlled intervention trials have demonstrated that water soluble fiber effectively lowers serum total and low-density lipoprotein cholesterol concentrations and improves insulin resistance. Furthermore, epidemiological research has suggested that diets rich in dietary fiber offer protection against CVDs. These results underline the existing dietary guidelines for increasing the intake of dietary fiber.

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