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Role of Dietary Fiber in Chronic Disease Prevention: A Comprehensive Review

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Abstract

Dietary fibre is vital to human health and may be found in plant-based meals. It comes in two varieties, soluble and insoluble, both of which have important health advantages. The purpose of this article is to review the diverse literature that has been conducted on the function of dietary fibre in the prevention of chronic diseases. This review emphasises the critical role that dietary fibre plays in avoiding chronic conditions such obesity, type II diabetes, cardiovascular disease, and inflammation. Better insulin sensitivity, weight control, and general metabolic health are all facilitated by both insoluble and soluble fibres. Improving assessment tools and establishing a harmonised global definition are indispensable for the advancement of public health policies and research. The promotion of fiber-rich diets through the consumption of fruits, vegetables, whole cereals, and legumes, as well as the provision of affordable nutritious foods and education, is essential. In order to improve long-term results and lower illness burdens across a variety of groups, healthcare practitioners should include fibre recommendations into the treatment of chronic diseases.

Keywords: Dietary Fiber, Chronic Disease, Prevention, Human Health, Cardiovascular Disease, Type II Diabetes, Obesity, Inflammation.

1 Introduction

Dietary fibre has long been known to have positive effects on digestive or gastrointestinal health. The 1970s saw the observation of low colorectal cancer rates in Africa, which led to the concept of a preventive effect [1]. "In 1991, the Committee on Medical Aspects of Food Policy (COMA) established

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the UK" Dietary Reference Value (DRV) for fibre based on evidence of increased faecal weight with fibre intake and the finding that populations with higher faecal weights tended to have a lower incidence of bowel disease. In the more recent publication Carbohydrates and Health, "the UK's Scientific Advisory Committee on Nutrition (SACN)" summarised its conclusions after reviewing the abundance of research produced during the next 25 year. [2]. Numerous prospective cohort studies have shown evidence that higher intakes of total dietary fibre, especially cereal fibre and whole grains, are linked to a decreased risk of colorectal cancer and cardio-metabolic illness. In light of this research, the UK DRV for fibre intake was increased for those aged 16 and older from 18 g of non-starch polysaccharide (NSP) fibre "or about 24 g of AOAC fibre1) per day to 30 g of AOAC fibre per day". This is equivalent to the recommended intakes in other countries, however it is greater than "the European Food Safety Authority's (EFSA) and Ireland's standards" [3], [4].

A. Dietary fiber

One kind of nutrient is dietary fibre, which is a carbohydrate. The body is unable to assimilate or ingest the components of plant nutrients that are classified as fibre. It differs from other nutrients like proteins, lipids, and other carbs like sugars and starches because of this. These nutrients are broken down and absorbed by the body. Rather, fibre exits the body quite undamaged after passing through the colon, small intestine, and stomach [5]. Fibre comes in two primary varieties:

- **Soluble fiber:** Water dissolves this kind of fibre. It slows down digestion in the stomach by forming a gel-like substance. It may assist in lowering blood sugar and cholesterol. Apples, bananas, avocados, oats, peas, beans, carrots, citrus fruits, barley, and psyllium are all sources of soluble fibre.
- **Insoluble fiber:** Water does not dissolve this kind of fibre. It gives faeces more volume and facilitates the passage of materials through the digestive system. Therefore, it may prove advantageous for individuals who experience constipation or have difficulty passing faeces on a consistent basis. Whole-wheat flour, wheat cereal, almonds, legumes, and vegetables like cauliflower, green beans, and potatoes are all excellent sources of insoluble fibre.

Soluble and insoluble fibre are present in the majority of high-fiber plant diets. Whether a plant is a fruit, vegetable, or whole grain affects how much of each kind of fibre it contains. However, by consuming a range of foods high in fibre, you may have both kinds of fibre [6].

B. Chronic Diseases

Longer than three months, chronic illnesses might need ongoing care because of a significant decline in health. For years or perhaps a lifetime, chronic illnesses may persist. Age is a common factor in the development of these diseases, which can typically be managed but are rarely cured [7]. The main causes of early mortality and disability are chronic illnesses. People who have a chronic illness must limit their lifestyle and deal with the challenges of living with it. Whether they are physical or mental, chronic illnesses may have an impact on a person's psychological, social, physical, and sexual well-being. In light of this, patients with chronic diseases necessitate ongoing assistance and care [8].

C. Fiber and disease prevention

1. Cardiovascular disease

Fibre consumption has been shown to be negatively correlated with the risk of cardiovascular disease (CVD) by several meta-analyses. Reduced inflammation, better blood pressure control, and lower levels of "total cholesterol and low-density lipoprotein (LDL)" are all associated with higher dietary fibre intake. One study also discovered that a 9% reduction in the risk of cardiovascular disease is associated with "every 7 g/day increase in dietary fibre". By binding to bile acids and facilitating their elimination, fibre also decreases cholesterol and lessens the risk of atherosclerosis [9]. Beta-glucans, which are abundant in whole grains, have been shown to lower blood pressure and enhance endothelial function. In addition, high-fiber diets are linked to enhanced arterial elasticity, which reduces cardiovascular strain and improves circulation. In addition, fibre consumption has been linked to decreased levels of C-reactive protein (CRP), a critical indicator of systemic inflammation that contributes to the progression of cardiovascular disease [10].

2. Type 2 diabetes

By altering digestion and glucose absorption, dietary fibre also enhances insulin sensitivity and glycaemic management. According to epidemiological research, those who consume the most fibre may be 20–30% less likely to acquire type 2 diabetes.4,6 Cereal fibres have shown notable protective benefits [11]. Soluble fibre also lessens postprandial glucose increases by delaying the absorption of carbohydrates. This reduces the need for insulin and stabilises blood sugar levels, which lessens the chance of insulin resistance. Improved metabolic health has been associated with a more varied gut flora, which is another benefit of fibre. Diets rich in fibre lower systemic inflammation, which is a key player in the development of type 2 diabetes. Glucagon-like peptide-1 (GLP-1), a hormone involved in glucose metabolism and hunger control, is one of the gut-derived hormones that fibre also increases [12].

3. Colorectal cancer

A lower risk of colon cancer is closely linked to dietary fibre intake, particularly from whole grains. Fibre minimises colonic cells' exposure to carcinogens by increasing stool size and shortening the transit time through the gut. Furthermore, SCFAs are produced during the fermentation of fibre and have anti-cancer and intestinal health benefits. Fibre is believed to modify the composition of the intestinal microbiota, which in turn enhances detoxification pathways and decreases the production of hazardous metabolites, according to research. It has been shown that certain fibres, including resistant starch, boost butyrate synthesis, which benefits colonic epithelial cells and may stop the development of tumours. Additionally, consuming more fibre is linked to a decrease in pro-inflammatory cytokines, which aid in the development of cancer [13].

D. Sources of fiber

Whole foods, not pills, are the best way to get the recommended amount of fibre, according to research. "Legumes like lentils, chickpeas, and black beans", as well as whole grains like brown rice, oats, and whole wheat bread, are important nutritional sources [14].

Additionally, dietary fibre is abundant in fruits, vegetables, and nuts and seeds, including broccoli, carrots, and verdant greens, as well as almonds, flaxseeds, and chia seeds.

The majority of people eat much less fibre than the current dietary standards, which say that women should consume 25 g and men should ingest 38 g daily. But eating more plant-based meals, switching to whole grains from refined ones, and selecting snacks high in fibre are all necessary to increase fibre consumption [15].

In order to promote long-term adherence, dietary education programs may also assist people in comprehending the sources of fibre and making small adjustments.

2 Literature Review

(Zhang et al., 2025)[16] The burden of cardiovascular disease (CVD) on healthcare systems is growing as it continues to be a major cause of morbidity and death worldwide. The progression and development of cardiovascular disease are significantly influenced by dietary factors. Dietary fibre is one of them that has gained attention as a potentially changeable component that may affect the risk of CVD. However, there is still much to learn about the precise and separate effects of dietary fibre on CVD, which makes this field of study both difficult and crucial. Cardiovascular diseases may be mitigated through numerous mechanisms by increasing the consumption of dietary fibre. In order to increase the consumption of dietary fibre from a variety of sources, it would be advantageous to create and disseminate healthcare interventions that would raise public awareness of the health benefits of dietary fibre, encourage "the consumption of fiber-rich foods, and advocate for a healthier diet".

(Alahmari, 2024) [17] Numerous chronic illnesses, including obesity, type II diabetes, colon cancer, cardiovascular disease (CVD), and inflammation, may be prevented by increasing fibre consumption, according to research. Fibre consumption is a critical focus for disease prevention, as these health conditions are significant global challenges. Nonetheless, there are a number of difficulties in researching how fibre affects health. Results are hard to generalise because of differences in fibre types and bioavailability factors. Data may also be inaccurate since food consumption is often self-reported. The methodology used in many research is also inconsistent, and the short study durations make it difficult to evaluate long-term health results. Because of these factors, it is more difficult to reach definitive conclusions regarding the complete spectrum of fiber's health benefits. Increasing consumption of foods high in fibre, such as vegetables, fruits, whole grains, and legumes, is still a highly advised way to improve health and lower the risk of chronic illness, despite these obstacles.

(Jama et al., 2024) [18] In order to solve this shortcoming, we analyse and support dietary fibre as a crucial lifestyle change to control high blood pressure. The definition of dietary fibre, the literature supporting its use to "lower blood pressure and prevent cardiovascular disease", the mechanisms involved, evidence-based target levels of fibre intake, examples of how patients can meet these targets, and unanswered questions in the field are all covered. This would promote the creation of metabolites termed short-chain fatty acids, which are generated from the gut microbiota and reduce blood pressure, as well as a healthy gut flora. A greater understanding of dietary fibre objectives and how to meet them

would help medical teams better educate and empower patients to increase their intake of fibre, which will decrease their blood pressure and risk of cardiovascular disease.

(Dharmatti et al., 2023) [19] Overnutrition, a lack of physical exercise, and fast socioeconomic growth have all contributed to the global pandemic of "type 2 diabetes mellitus (T2DM)", particularly in Asian nations. One of the most significant strategies for the prevention and management of T2DM is the promotion of healthful dietary habits. An increased intake of dietary fibre (DF) is significantly associated with a decreased risk of developing type 2 diabetes, according to a number of research, most of which were conducted in Western nations. A narrative review was conducted, with a particular emphasis on the macronutrient DF. For this, Google Scholar and PubMed were used. The objective was to review the latest medical studies on the health benefits of DF, with a focus on the impact of DF intake on glycaemic control.

(Fatima et al., 2023) [20] Despite being underconsumed, dietary fibre (DF) is an important part of the diet in North America. It is believed that DF has anti-inflammatory disease-modifying properties via short chain fatty acid breakdown products linked to the gut microbiota. As of right now, research has shown the strongest correlations between DF consumption and decreased obesity risk, better weight loss results, and decreased cardiovascular disease (CVD) risk. There is no proof that DF consumption is beneficial for ulcerative colitis (UC) in particular, and there is only poor evidence linking it to the risk of inflammatory bowel disease (IBD), IBD remission, and a lower risk of Crohn's disease flare-ups. There is conflicting data about the relationship of DF consumption with the prevention of colorectal cancer (CRC). There was a paucity of randomisation or control over the varieties and origins of fibres in the studies. Counselling patients to increase their intake of DF may be a cost-effective way to reduce the burden of chronic illness, given the existing positive connections of DF on managing obesity and CVD.

(Waddell & Orfila, 2023) [21] World populations are currently confronted with a significant challenge: obesity, a diet-related disease that is largely preventable. Obesity is a significant risk factor for conditions including "cardiovascular disease (CVD), type 2 diabetes mellitus (T2DM)", and several types of cancer. Mostly composed of polysaccharides, dietary fibre is a complex assemblage of non-digestible molecules. Higher dietary fibre intakes have been shown in several epidemiological studies to statistically significantly lower the risks of obesity, type 2 diabetes, cardiovascular disease, colorectal cancer, and premenopausal breast cancer. Numerous direct and indirect causes have been suggested, such as changed digestion and absorption, altered bile and cholesterol metabolism, decreased hunger, and activation of gut hormones such "glucagon-like-peptide-1 (GLP-1) and peptide YY (PYY)". These may function via mechanisms involving aromatase enzymes, histone deacetylase (HDAC), and G-protein-coupled receptors (GPRs). Consuming fibre ultimately lowers the risk of type 2 diabetes, cardiovascular disease, and several types of cancer by enhancing insulin sensitivity and glucose levels. In order to avoid obesity and the chronic diseases that are linked to it, diets high in dietary fibre should be promoted.

(Xu et al., 2022) [22] Although there is conflicting and limited data about the relative contributions of soluble and insoluble fibre to mortality risk, a number of research indicate that dietary fibre intake may lower mortality risk. Therefore, the purpose of this research was to thoroughly assess the effects of

various forms of dietary fibre consumption on mortality from cardiovascular disease, cancer, and all causes of "death in the large-scale Prostate, Lung, Colorectal, and Ovarian Cancer (PLCO) Screening Trial". Total fibre, soluble fibre, and insoluble fibre intakes were associated with reduced risks of all-cause, cardiovascular, and cancer mortality in this large, "nationally representative sample of the US adult population".

3 Conclusion

Finally, dietary fibre is essential for the prevention and treatment of a number of chronic conditions, including as inflammation, type II diabetes, obesity, and cardiovascular disease (CVD). In addition to improving insulin sensitivity, soluble and insoluble fibres also regulate nutritional absorption, improve digestive health, and aid in weight control. Fiber's function in lowering the risk of obesity and cardiovascular disease is well-established, but weaker, observational research points to possible advantages for diseases including colorectal cancer (CRC) and inflammatory bowel disease (IBD). Harmonizing international definitions of dietary fiber and improving tools for intake assessment are essential to ensuring global consistency in research and recommendations. Strategies for managing chronic diseases should include increasing fibre intake via whole foods such "fruits, vegetables, legumes, nuts, and whole grains". This should be emphasised in public health education. Healthcare providers should counsel patients on the importance of fiber, offering tailored advice and educational resources. Furthermore, particularly in underprivileged populations, legislative changes are required to provide access to reasonably priced, high-fiber diets. To further our knowledge of the processes through which fibre affects health and to influence future dietary recommendations and food industry policies, further study in a variety of dietary situations is required.

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