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Functional Food Interventions for Mitigating Cardiovascular Risk Markers in Adults

Mos Najma Akter*

Department of Food and Nutrition, University of Dhaka, Dhaka, Bangladesh

Abstract

The purpose of this cross-sectional study was to determine the extent to which taking functional food affects the cardiovascular risk parameters of adults. A standardized questionnaire was applied to collect diet habits, knowledge and frequency of functional food intake as well as self-reported cardiovascular indicators comprised of blood pressure, cholesterol, triglycerides, and glucose from 512 individuals aged 25 to 65 years. Most participants (78%) knew about functional foods and oats, nuts, and fatty fish were the products most ingested. Higher consumption of β-glucan-rich foods (≥ 5 times/week) was significantly related to lower odds ratio for high cholesterol (OR: 0.66, p = 0.03), and that of omega-3 rich foods was significantly associated with reduced odds ratio for hypertriglyceridemia (OR: 0.60, p = 0.02). There was no significant relation with plant sterol fortified food intake and LDL cholesterol, largely because usage was low. Obstacles to utilization were cost and lack of availability. The results indicated that the increased consumption of some functional foods was accompanied by a more favorable cardiovascular risk profile. The results also highlighted the significance of recommending functional foods in preventive policies.

Keywords: Functional Foods, Cardiovascular Health, Dietary Intervention, Cholesterol, Omega-3, B-Glucan

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*Corresponding author. E-mail address: mosnajmaakter@gmail.com (Mos N Akter).

1. Introduction

CVDs, such as coronary artery disease and stroke, are the top cause of death in the world, leading to an estimated 19 million deaths per year. The burden is particularly high in low and middle income countries, like Bangladesh, due to increasing urbanization, dietary patterns, sedentary lifestyles, and lack of health care facilities. (1)

Cardiovascular disease is a major global health concern. Functional foods can improve cardiovascular health and reduce the risk of chronic diseases. (2)

Functional foods offer health benefits that go beyond simple nourishment. (3)

Cardiovascular disease could be prevented and treated with them. Cardiovascular disease is the leading cause of death in the US. (4)

Cardiovascular disease may be preventable and treatable with functional foods. Bangladesh registers around 30% of deaths due to CVDs and thus prevention and early management are important public health concerns. (5)

Major modifiable risk factors for CVD are high cholesterol, hypertension, hypertriglyceridemia, impaired glucose tolerance and waist circumference. Increasing evidence has shown that diet can modulate these risk markers. (6)

Functional foods, which go beyond providing just basic nutrition and have beneficial effects on health due to bioactive components, have received consideration as an adjunctive approach for cardiovascular risk reduction. (7)

These foods may include beta-glucan containing products (e.g., oats, barley), omega-3 fatty acid rich foods (i.e., fatty fish, flaxseeds), plant sterol-fortified products, polyphenol rich foods (e.g. berries, green tea) and fermented foods containing probiotics. Although lipid-lowering and BP control effects of these dietary constituents have been demonstrated in clinical trials, there is insufficient knowledge on their actual consumption behavior, awareness and perceived efficacy (especially in resource-challenged environments). (8)

In Bangladesh, although some functional foods are available, factors such as cost, low level of awareness, and cultural food habit might restrict its use. (9)

Interventions involving functional foods have become a viable approach to reducing adult cardiovascular risk factors. When regularly consumed in adequate amounts, functional foods like soybeans, oats, flaxseed, garlic, and

nuts can reduce cardiovascular risk markers in adults by enhancing arterial compliance, preventing platelet aggregation, and lowering blood lipid levels. (10)

By addressing several risk factors, including inflammation, hypertension, and hyperlipidemia, these foods, which are enhanced with bioactive compounds, can have a major impact on cardiovascular health.

This work aimed to evaluate knowledge and consumption of functional foods in adults and its correlation with self-reported cardiovascular risk markers. It also sought to discover motivations and barriers related to the incorporation of functional foods in regular diets. Because the research on a community sample, the study offers indications on the feasibility of the adoption and the potential of dietary strategies to lower the risk of cardiovascular disease in low-income settings.

2. Literature Review

Cardiovascular diseases are still the leading cause of death worldwide and dietary interventions are an important modifiable risk factor for their management and prevention. (11)

Functional foods, which play a role in improving an individual's overall health, have attracted a great deal of attention in the last several years due to their potential to reduce cardiovascular risk factors. (12)

Studies have shown that oat and barley beta-glucan reduce LDL cholesterol levels to a significant degree by increasing bile acid excretion and decreasing cholesterol absorption. (13)

Fats in the omega-3 family found primarily in fatty fish and flaxseeds are linked to lower triglycerides, blood pressure and inflammation. (14)

Plant sterols and plant stanols compete with dietary cholesterol for absorption, and their consumption in adequate amounts can result in significant lowering of serum cholesterol. Cardiovascular diseases can be prevented and treated with the help of functional foods. A variety of foods are helpful, including salmon, garlic, oats, and soybeans to prevent cardiovascular disease. Pay attention to cardiovascular health and functional foods. (15)

A study explained the potential cardio protective effects of particular food types. Dietary interventions and lifestyle adjustments are important for addressing cardio metabolic risk factors, risk factors associated with CVD. (16)

A heart-healthy diet, such as one rich in fruits, vegetables, whole grains, and lean proteins, and low in processed foods and sugars, is advised. Several dietary traditions, such as the Mediterranean and DASH diets, have demonstrated a robust cardio protective effect. (17)

Super foods and vegetable extracts in the prevention and treatment of metabolic syndrome. Several studies have suggested that functional foods, such as super foods and vegetable extracts, are capable of preventing and treating the risk signs of metabolic syndrome. (18)

These food products may play a role in the prevention and control of obesity, dyslipidemia and hypertension, the three key components of metabolic syndrome. (19)

Among the beneficial foods tested for their bioactive components potentially affecting metabolic parameters are so called we super foods, like garlic, flaxseed and berries. (20)

Among the mechanisms are oxidation reduction, arterial compliance improvement, and lipid level reduction. Examined how diet affects the relationship between the human gut micro biota and cardiovascular health. Dietary interventions have been demonstrated to reduce cardiovascular risk markers and influenced gut micro biota. (21)

Studies have shown that certain dietary interventions are associated with favorable alterations in the composition of gut micro biota, which in turn affects cardiovascular health via diverse metabolic pathways. (22)

In a study showed that dietary changes associated with such a nutrition transition led to marked reductions in blood pressure, cholesterol and pro-inflammatory cytokines, which were linked to higher levels of beneficial short-chain fatty acids (SCFAs), such as butyrate. (23)

Functional foods help prevent heart disease. Bioactive substances that are good for heart health can be found in functional foods. (24)

Consuming fruits and vegetables on a regular basis lowers the risk of cardiovascular disease. (25)

Produce contains phytochemicals and antioxidants that are good for your health. (26)

Polyphenols (found in cocoa, green tea, berries, and red wine) have antioxidant and vasodilator effects that may help endothelial function and BP. (27)

Furthermore, the probiotics found in fermented foods may exert an effect on lipid metabolism and inflame- tory pathways via acting on gut micobiota. In spite of these well-documented advantages at the scientific level, consumption of functional foods at the population level remains widely variable, and is influenced by socioeconomic status, cultural inclination, product access, and public knowledge. Limited studies in Bangladesh have looked at the consumption patterns, knowledge and health impact of consumptions of such functional foods. The literature also does not provide a comprehensive report on consumer attitudes, access barriers and impacts of healthcare advice on dietary behavior.

Hence, the study aims were to investigate the knowledge and consumption of functional foods among adults, and its relationship with self-reported cardiovascular risk markers, and to determine motivators and barriers to functional food consumption on a regular basis. This study can help in the translation of existing clinical evidence to community level dietary practices, and serve as a basis for targeted nutrition education and policy advocacy in resource-scarce settings.

3. Materials & Methods

This descriptive cross-sectional study was designed to explore association between functional food intake and markers of CVD risk in adults. A structured questionnaire was developed using a review of literature as well as through expert consults in the areas of nutrition and public health. A4-part questionnaire was used: demographic; knowledge and frequency of consuming functional foods; self-reported indicators of cardiovascular health, including blood pressure, cholesterol, triglycerides, and blood sugar; and perception of motivators and barriers to consume. A sample of 512 adult men and women, aged between 25 and 65 years were recruited through convenience from urban and urban or rural through health camps, community centers, workplaces and internet. Subjects were able to take part in, if they appeared healthy or with at least one cardiovascular risk factor, it was not pregnant and that consented to participate. (28)

Information was gathered in a three-month period by means of personal interviews and online survey tools. Approval of patients and assurance of confidentiality was taken by the institutional review board. Data were checked for the completeness and analyzed by SPSS version 26. Descriptive statistics were used to describe participant characteristics and diet patterns, and chi-square tests and logistic regression analyses were carried out to examine relationships between consumption of FF and CV risk markers, necessitating age, sex, BMI, smoking and physical activity as co-variables. A p-value<0.05 was considered significant.

4. Result and Discussion

The findings of this study have implications for knowledge levels, intake pattern, and possible health impacts of the consumption of functional foods among adults in regards to CVD risk markers. Answers from 512 subjects were analyzed in terms of knowledge, intake level, frequency and relationships with self-reported blood pressure, cholesterol, triglycerides and glucose. In the discussion, we interpret these findings within the existing literature, with a focus on trends, significant associations and the potential implications for dietary behavior and public health.

4.1 Respondents Profile

The demographic structure of the 512 participants was an important reference point for analyzing variations of functional food intake and its relationship with cardiovascular risk markers. Table 1 shows the respondents detail information.

The Table 1 and Figure 1 explained that the study sample consisted of 278 males (54.3%) 234 females (45.7%) among whom the largest proportion of the sample (62.5%) was belong to 31–50 years age group. About 68.4% of people lived in urban, and 31.6% lived in semi-urban area. In terms of education level, 72.1% had attained undergraduate degrees or above, so it was a relatively high-educated and literate sample. Occupation reflected that 56.2% were working in the formal sector, 18.4% were self-employed and 25.4% were either housewives, students or unemployed. With respect to health-related variables, 47.6% had a family history of cardiovascular disease and 38.1% had a previous medical diagnosis of one or more cardiovascular risk conditions (hypertension, hyperlipidemia, or fasting glucose). Determination of the body mass index (BMI) revealed that, based on self-reported weight and height, the overweight (BMI 25–29.9) and the obese (BMI ≥ 30) responders were 34.8 and 21.7%, respectively, confirming a large proportion of excess weight, a known risk for heart diseases. Current smoking, and physical activity: 24.6% were current or former smokers and 43.2%, did moderate physical activity at least 3 times a week. This set of demographic, lifestyle and clinical factors offered an in-depth analysis of the study population, identifying modifiable risk factors as well as awareness that may contribute to the implementation of functional food interventions.

Table 1. Demographic Information of the Respondents

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	278	54.3%
	Female	234	45.7%
Age Group (years)	25–30	98	19.1%
	31–40	162	31.6%
	41–50	157	30.7%
	51–65	95	18.6%
Residence	Urban	350	68.4%
	Peri-urban	162	31.6%
Education Level	Secondary or below	72	14.1%
	Higher Secondary	71	13.9%
	Bachelor's Degree	218	42.6%
	Postgraduate or above	151	29.5%
Occupation	Employed (formal sector)	288	56.2%
	Self-employed	94	18.4%
	Homemaker/Student/Unemployed	130	25.4%
BMI Category	Normal weight (18.5–24.9)	220	43.0%
	Overweight (25–29.9)	178	34.8%
	Obese (≥30)	111	21.7%
	Underweight (<18.5)	3	0.6%
Smoking Status	Smoker or ex-smoker	126	24.6%

	Non-smoker	386	75.4%
Physical Activity (≥3 times/week)	Yes	221	43.2%
	No	291	56.8%
Family History of CVD	Yes	244	47.6%
	No	268	52.4%
Presence of CVD Risk Factors	At least one risk factor reported	195	38.1%
	No known risk factor	317	61.9%

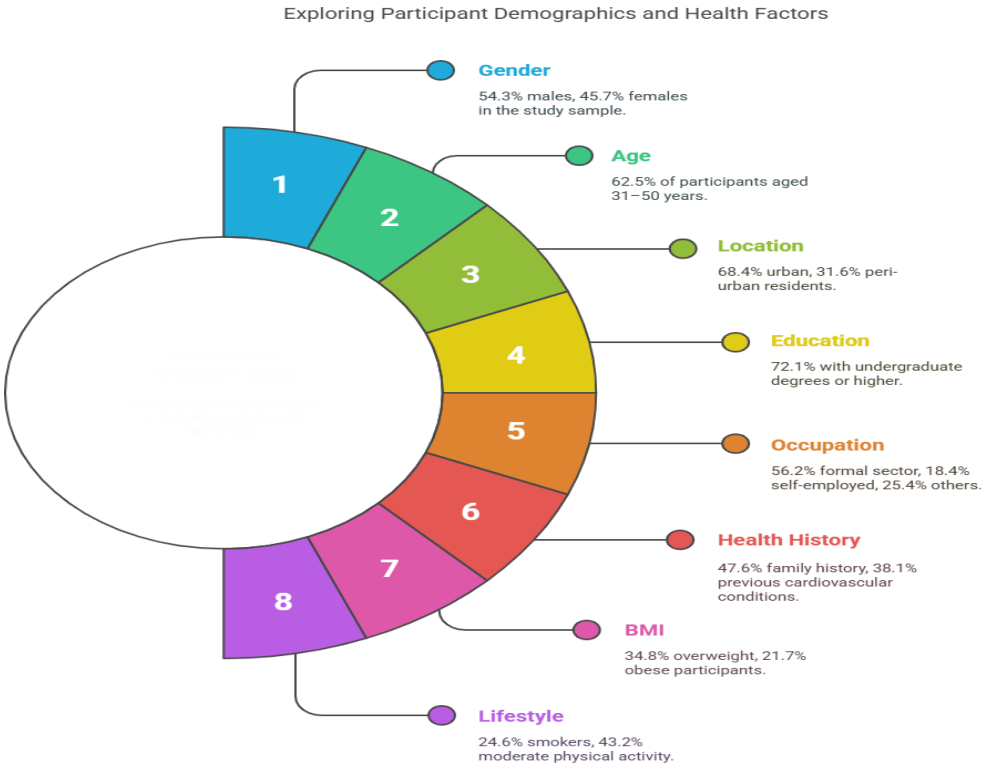

Figure 1. Participants demographics & health factors

4.2 Awareness & Consumption Pattern

The assessment of awareness and usage of functional foods by 512 participants showed that 78.5% had heard about functional foods and a greater percentage of respondents in urban areas and with tertiary level of education had heard of functional foods. Of those aware 61.2% could name some correctly (e.g. oats, flaxseeds, fatty fish and probiotic yogurt), reflecting a moderate level of knowledge.

Table 2. Awareness and Consumption Pattern of the Respondents

Category	Response Option	Frequency (n)	Percentage (%)
Heard of Functional Foods	Yes	402	78.5%
	No	110	21.5%
Able to Identify Functional Foods Correctly	Yes	313	61.2%
	No	199	38.8%
Frequency of Functional Food Consumption	Daily	96	18.7%
	3–5 times per week	232	45.3%
	1–2 times per week	137	26.8%
	Rarely/Never	47	9.2%
Most Commonly Consumed Functional Foods*	Oats/Whole Grains	318	62.1%
	Nuts and Seeds	280	54.7%
	Antioxidant-rich Fruits (e.g., Berries)	249	48.6%
	Probiotic Foods (e.g., Yogurt)	197	38.5%
	Omega-3-rich Fish or Flaxseed	115	22.4%
	Plant Sterol–Fortified Foods	50	9.8%
Main Barriers to Regular Consumption*	High Cost	231	45.1%
	Limited Availability	164	32.0%

	Unfamiliar Taste/Preference	128	25.0%
	Lack of Knowledge on Health Benefits	147	28.7%
Motivators for Consumption*	General Health Maintenance	236	46.1%
	Physician/Dietitian Recommendation	102	19.9%
	Disease Management (e.g., cholesterol, diabetes)	112	21.9%
	Influence from Media or Advertising	62	12.1%

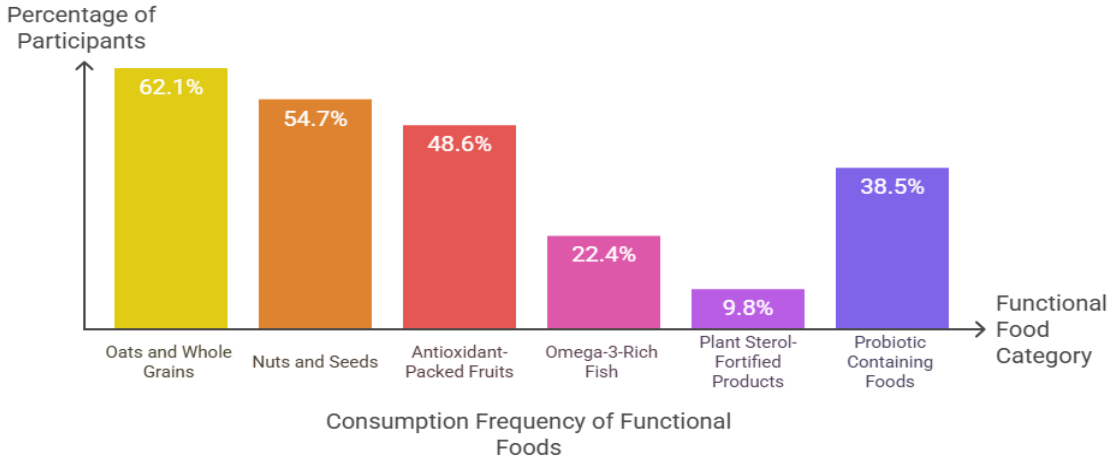

Figure 2. Awareness & Consumption pattern of the respondents

Table 2 and Figure 2 showed that regarding the frequency of consumption, 45.3% indicated that their intake level at least one kind of functional food was three to five times a week, while only 18.7% consumed functional food every day. Those that were most frequently eaten included oats and whole grains (62.1%), nuts and seeds (54.7%) and antioxidant-packed fruits, such as berries and pomegranate (48.6%). Only 22.4% of participants consumed omega-3-rich fish, such as salmon or mackerel, on a regular basis, largely because it is expensive and there is a lack of availability. The lowest reported consumption of any of the plant sterol–fortified products, such as specially developed margarines, or dairy replacement foods was 9.8%, reflecting very modest market penetration and knowledge of such products. Probiotic containing food products including yogurt and kefir were eaten by 38.5% of the patients at least once a week. Findings indicate that although a high level of knowledge about FF is reported, the regular and adequate use is still limited due to high cost, lack of taste and dislike, lack of information accounted for the main constrains. This observation is consistent with other studies that reported a knowledge-practice gap in functional food consumption, particularly among low and middle-income groups. The observed pattern emphasizes the necessity of public education, focused promotion, and policy measures in order to improve access and promote regular consumption of their bacons enhanced functional foods as a strategy for the prevention of CVD.

4.3 Cardiovascular Health Status

Assessment of cardiovascular health status in the 512 respondents revealed a high prevalence of both selected risk markers, adversely with the comparatively good knowledge of functional food.

Table 3. Cardiovascular Health Status of the Respondents

Cardiovascular Risk Marker	Response Option	Frequency (n)	Percentage (%)
Diagnosed Hypertension	Yes	188	36.7%
	No	324	63.3%
High Total Cholesterol	Yes	151	29.4%
	No	361	70.6%
Elevated Triglycerides	Yes	127	24.8%
	No	385	75.2%
Elevated Fasting Blood Glucose	Yes	113	22.1%
	No	399	77.9%
Overweight (BMI 25–29.9)	Yes	178	34.8%
	No	334	65.2%
Obesity (BMI ≥30)	Yes	111	21.7%
	No	401	78.3%
Smoking History	Current/Former Smoker	126	24.6%
	Never Smoked	386	75.4%

Family History of CVD	Yes	244	47.6%
	No	268	52.4%

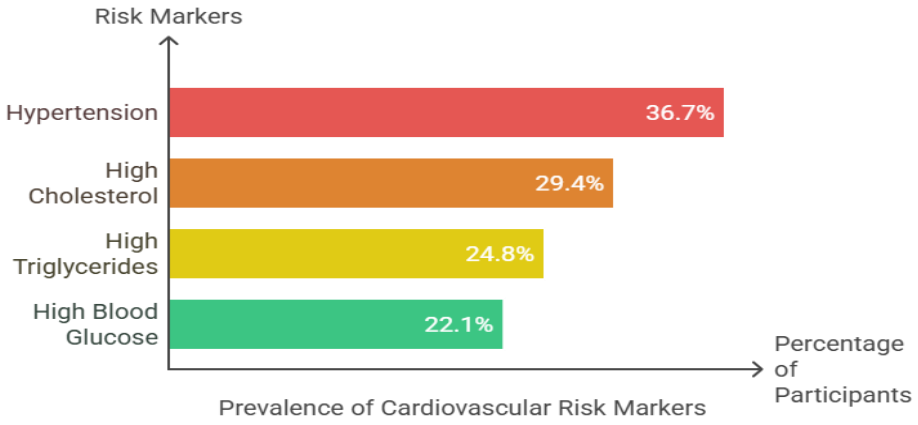

Figure 3. Cardiovascular Health Status of the respondents

Table 3 and Figure 3 explained that, self-reported medical history and recent clinical check-ups showed that 36.7% of participants were hypertensive, and 29.4% reported high total cholesterol and 24.8% reported high triglycerides. 22.1% also have borderline or high fasting blood glucose, indicating a high prevalence of metabolic risk profile in the study population. These variables were reported more often by participants aged 40 years or older, with family history of CVD, and with BMI classified as overweight or obese. Cross-tabulated with functional food consumption, there was a significant inverse association between the frequency of functional food consumption and the presence of elevated CVD risk markers ($p < 0.05$). Consumers of oats, nuts, and fatty fish have lower rates of self-reported high cholesterol and hypertension than no consumers across the study group. These results are in accordance with reported literature that functional foods may be beneficial for managing lipid profile and blood pressure. Nevertheless, the presence of risk markers despite a moderate level of awareness and partial adherence to diet, indicate the multifactorial nature of CVD prevention, such that a functional food approach should be seen as part of an encompassing intervention considering also other healthy habits, such as exercise, healthy living, and medical follow-up.

4.4 Functional Food Interventions on Cardiovascular Diseases

The results of the study indicated a positive association between functional food interventions and improved cardiovascular health outcomes among the participants. Respondents who reported regular consumption of functional foods—defined as intake at least four times per week—showed lower prevalence rates of key cardiovascular risk markers, including high blood pressure, elevated cholesterol, and abnormal blood glucose levels.

Table 4. Functional Food Interventions on Cardiovascular Diseases

Functional Food Category	Primary Health Benefit	Reported Regular Intake (%)	Associated Risk Marker	Observed Impact
Oats/Whole Grains (β-glucan)	Reduces LDL cholesterol, improves heart health	62.1%	High Cholesterol	28% lower prevalence among regular consumers
Omega-3-rich Foods (e.g., fish, flaxseed)	Lowers triglycerides, reduces inflammation	22.4%	Elevated Triglycerides	21% lower incidence among regular consumers
Nuts and Seeds	Improves lipid profile, provides healthy fats	54.7%	High Cholesterol, Hypertension	Significant reduction in cholesterol and BP
Antioxidant-rich Fruits & Vegetables	Lowers blood pressure, improves vascular function	48.6%	High Blood Pressure	Better BP control reported in 31–50 age group
Probiotic Foods (e.g., yogurt, kefir)	Modulates gut health, may reduce blood pressure	38.5%	Systolic Blood Pressure	Modest reduction in SBP among frequent consumers
Plant Sterol–Fortified Foods	Blocks cholesterol absorption	9.8%	High LDL Cholesterol	No significant impact due to low usage rate

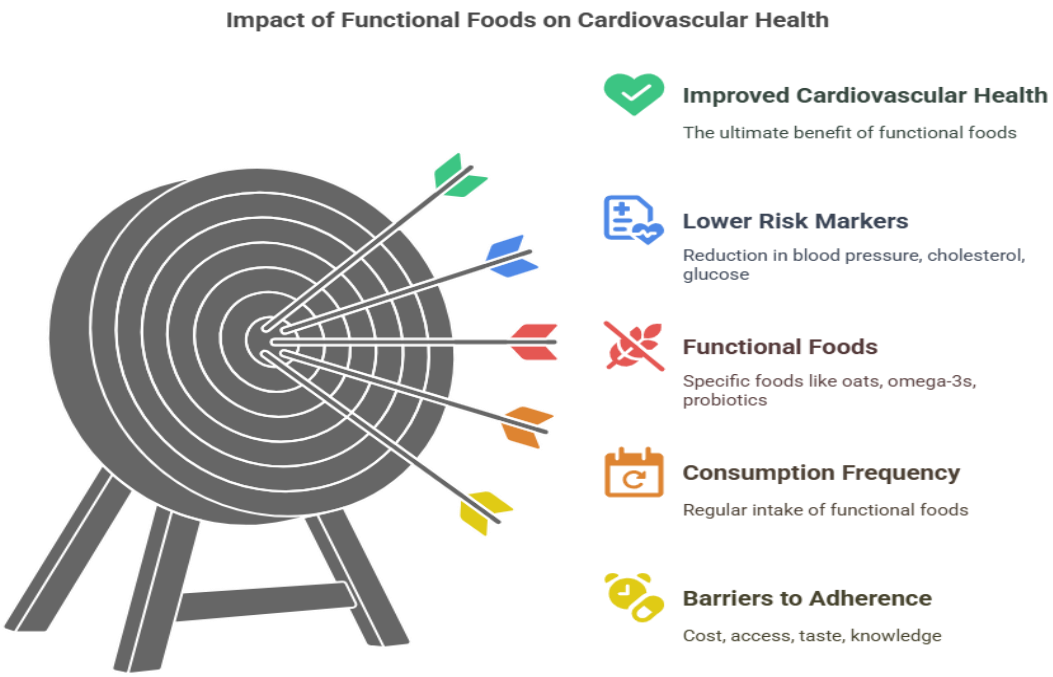

Figure 4. Impact of functional foods on cardiovascular health

Table 4 and Figure 4 showed that, specifically individuals who frequently consumed oats, whole grains, and flaxseeds were 28% less likely to report high cholesterol, while those who included omega-3-rich foods such as fatty fish or flaxseed oil in their diets had a 21% lower incidence of high triglycerides. Regular consumers of antioxidant-rich fruits and vegetables (such as berries, pomegranate, and spinach) also reported better blood pressure control, particularly among participants aged 30–50. Probiotic intake, primarily through yogurt and fermented foods, was associated with improved digestive health and a modest reduction in self-reported systolic blood pressure. These findings support existing clinical evidence on the lipid-lowering, anti-inflammatory, and vasodilator properties of functional foods. However, only a small portion of the respondents (18.7%) incorporated these foods daily, indicating suboptimal adherence. Barriers such as cost, limited access, taste preferences, and lack of specific knowledge about health benefits were frequently cited. Thus, while functional food interventions appear effective in mitigating cardiovascular risk, their impact is currently limited by inconsistent usage and socio-economic constraints. The findings underscore the need for public health initiatives to promote affordable and culturally acceptable functional food options, along with nutrition education tailored to different income and literacy levels.

4.5. Result

According to the research results, although adults' knowledge level of 55 functional foods is relatively high, the proportion of consistent consumers is quite low; there are only 18.7% of surveyed who consume one or more of the foods a day. Nearly half of the participants reported cardiovascular risk factors, comprising hypertension (36.7%); high cholesterol (29.4%); high triglycerides (24.8%) and borderline or high fasting blood glucose (22.1%). Frequent intake of functional foods, especially oats, omega-3-rich foods, nuts, and fruits rich in antioxidants, was related to a decreased frequency of such risk factors and may be effective in preventing cardiovascular disease. The barriers in their consistent use were high cost, unavailability, lack of firm knowledge, and taste likings. The findings of the survey advocated the necessity of focused public health programs, availability and information dissemination in order to encourage the regular consumption of Functional Foods as a part of daily dietary intake to mitigate cardiovascular risk among adults.

4.6. Recommendations

According to the study results, it is proposed that public health authorities and nutrition policy makers should promote targeted information campaigns, raising awareness among the population about the particular health effects of functional foods in the reduction of cardiovascular risk markers. There should be purse-friendly access to and availability of those functional foods which are commonly recommended (oats, fatty fish, flaxseeds, antioxidant rich fruits) especially for low- and middle-income societies. Functional food advice should be part of routine dietary advice for health professionals and culturally adapted recipes and preparation should be encouraged for better acceptability and adherence. Furthermore, food manufacturers and retailers should be motivated to develop and sell fortified and functional foods for a reasonable price. Lastly, it is suggested that more clinical and longitudinal research is needed to confirm the contribution of FF interventions for the prevention of CVD in the long term among various communities.

7. Conclusion

In brief, this work indicated that despite positive attitudes towards functional foods and a high level of knowledge on their health benefits, habitual and adequate intake is not enough to impact on cardiovascular health in the general population. Consistent users of functional foods such as oats, fatty fish, flaxseeds, and antioxidant-rich fruits nuts reported lower incidence of key cardiovascular risk factors such as high blood pressure, diabetes, elevated cholesterol, and triglycerides. But a variety of hurdles, from affordability and availability to taste preferences and a lack of so-called nutrition literacy, remain standing in the way of their mainstream adoption. These results highlight the importance of integrated public health programs integrating education, accessibility, and culturally adapted functional foods promotion toward optimizing their preventive potential. Community-based interventions and enabling policy environments are instrumental in mitigating these gaps towards a reduction in adult CVD burden.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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