

Mediterranean Diet for Cardiovascular Disease Control in Low-income Populations in the United States: Application of Community Outreach Services

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Abstract. In the US, cardiovascular disease (CVD) is a serious public health issue that disproportionately affects people with low incomes. The low-income populations are more likely to consume diets high in fats, refined grains, and added sugars which are considered as foods associated with a high Dietary Inflammation Index (DII). Due to the promotion of inflammatory processes and rising of low-density lipoprotein cholesterol (LDL-C) levels, foods with high DII increase the risk of CVD. On the other hand, it has been established that anti-inflammatory foods including fruits, vegetables, and whole grains, which are high in polyphenols, β -glucans, and other bioactive substances, can reduce these risks via a variety of antioxidant and metabolic processes. Notably, compliance with the Mediterranean diet in which low DII is a defining characteristic, has been identified as an effective strategy in reducing the risk of CVD. This paper highlights the need for accessible community-based health care and dietary counseling in the promotion of cardiovascular health behaviors through an analysis of dietary intake and cardiovascular health outcomes in low-income populations. Anti-inflammatory dietary patterns, such as the Mediterranean diet, in public health strategies aimed at reducing the risk of CVD in low-income populations, thereby contributing to the reduction of the burden of cardiovascular disease through nutritional interventions. This paper explores the relationship between socioeconomic status, dietary patterns, and CVD risk, emphasizing the critical role of community-based interventions and anti-inflammatory dietary patterns in addressing this disparity.

Keywords: Cardiovascular disease; mediterranean diet; low-income; community.

1. Introduction

Heart and blood vessel illnesses together referred to as cardiovascular disease (CVD) include rheumatic heart disease, coronary heart disease, cerebrovascular disease, and other conditions. Income level is a factor that affects the occurrence of CVD by influencing the dietary pattern of people. A study have shown that low-income populations have higher risks of CVD and confront worse CVD outcomes. And low-income populations are unlikely to undergo CVD risk factor screening or receive CVD prevention counseling [1]. Intake of fruits, vegetables, and whole grains is far lower in the United States than it should be.

According to a survey conducted in the United States based on 77,822 low-income people, these people consume more fat, refined carbohydrates, and added sugar [2]. The fat, refined grains and added sugar have high dietary inflammatory index (DII), which means they are pro-inflammatory. Overconsumption of fat and sugar can raise the level of low-density lipoprotein cholesterol (LDL-C), thereby raising the risk of CVD by releasing cellular contents and forming blood clots. Polyphenols β -Pectin and other active ingredients remove free radicals, including reactive oxygen species (ROS), reactive nitrogen, hypochlorous acid, and NO, from whole grains, vegetables, and fruits. A meta-analysis indicates that participants with highest DII have 32% higher risk of CVD [3].

This article aims to explore the relationship among dietary patterns, community assistance, and American low-income groups' prevalence of CVD. Besides, the role of anti-inflammatory diets in reducing the risk of CVD using the Mediterranean diet (MD) as an example is also been discussed.

2. The Dietary Gap between High and Low Income Groups

When compared to individuals that have higher incomes, individuals with lower incomes often consume less fruits, vegetables, and whole grains. Conversely, individuals with lower incomes tend to eat more refined cereals, fatty meats, and sugary beverages. A survey compared the food and nutrients taken by the low-income individuals (n=1108) and high-income individuals (n=3086) in United States. The survey shows the intake of whole grains, vegetables and fruits of low-income individuals are significantly lower than the one of high-income individuals [4]. As shown in Table 1.

Table1 Mean Consumption of Important Food Groups and Nutrients by SNAP Status among Adults in the US

Food and Nutrients	Survey-Weighted Mean Intake (95% CI)		P-value
	Low-income individuals(n=1108)	High-income individuals(n=3086)	
Fruits and vegetables, servings/day	1.31 (1.12-1.50)	2.04 (1.93-2.15)	<.001
Whole grains, servings/d	0.66 (0.58-0.73)	1.00 (0.96 1.04)	<.001
Refined grains, servings/d	4.92 (4.65-5.18)	4.96 (4.82-5.11)	.04
Sugar-sweetened beverages, servings/d	1.87 (1.54-2.20)	0.80 (0.70-0.89)	<.001
Total fat, % of energy	33.1 (32.6-33.6)	34.9 (34.5-35.3)	<.001
Saturated fatty acids, % of energy	10.9 (10.6-11.2)	11.1 (10.9-11.3)	.18
Monounsaturated fatty acids, % of energy	13.4 (12.7-14.2)	13.6 (13.2-14.0)	.90
Polyunsaturated fatty acids, % of energy	7.6 (7.3-7.9)	8.2 (8.1-8.4)	<.001
Polyunsaturated to saturated fat ratio	0.77 (0.73-0.81)	0.80 (0.79-0.82)	.05

3. Food Intake and Cardiovascular Disease

3.1. Fat

Low-income people's food contains high fat, which will lead to a elevations of Low density lipoprotein cholesterol (LDL-C). For a very long time, atherosclerotic cardiovascular disease (ASCVD) has been linked to LDL-C. Within the spectrum of low-density lipoprotein cholesterol, small, dense LDL-C (sdLDL-C) has the ability to suppress the expression of EGR2, which in turn causes the synthesis of cholesterol esters (CE) and a rise in the outflow of free cholesterol (FC). The accumulation of FC in large quantities can turn macrophages into powerful cell apoptosis inducers, causing the intracellular contents to be liberated and thrombus formation. The region under the LDL-C curves on age is used to compute the LDL-C exposure in a study with 4,958 individuals.

The research found that after the age of 40, the upper quartile (area > 2,875mg/dl × years) has higher risk of CVD event than the lower quartile (area < 2,115mg/dl × years); At the age of 60, the upper quartile had around 9% of CVD event occurring higher than the lower quartile [5].

3.2. Whole Grains and Refined Grains

Although the traditional belief that refined grains are an unhealthy diet, a meta-analysis on the relationship between CVD and refined grains has shown no significant correlation between refined grains and the risk of CVD [6]. But low-income people have more refined grains intake than whole grains intake. Whole grains are rich in bioactive compounds including polyphenols and fibers (β -glucan) can have beneficial effects on the metabolism of blood sugar and blood lipids, as well as the absorption of fatty acids. The functions of polyphenols and β -glucan are shown as below.

3.2.1 Polyphenols

Polyphenols have a cardiovascular protective mechanism due to their strong antioxidant effects. In detail, the protective effect of polyphenols on oxidative stress can eliminate free radicals such as reactive nitrogen, reactive oxygen species (ROS), hypochlorous acid, and NO, as well as products of lipid, protein, and DNA peroxidation. This protective effect can prevent endothelial dysfunction caused by ROS accumulation, including regulation of vascular tension, thrombus resistance, and cell adhesion [7]. Thereby reducing the occurrence of chronic inflammation, decreasing the progression of atherosclerosis and susceptibility to cardiovascular disease. Resveratrol is a natural polyphenolic compound that can significantly reduce the levels of inflammatory markers in cardiovascular disease patients, such as tumor necrosis factor alpha (TNF- α) (CI: -1.04, -0.06 MD=-0.55, 95%; p=0.02) and C-reactive protein (CRP) (CI: -0.1.13, -0.12, MD=-0.63, 95%; p=0.01). These inflammatory markers are involved in triggering the immune process of vascular remodeling and plaque deposition which are also related to the increased risk of cardiovascular disease [8].

3.2.2 β -glucan

Due to its large diameter, TG-rich lipoprotein (TRL) cannot directly penetrate the arterial wall and remains in the endothelium, resulting in the breakdown of triglycerides (TG) components into free fatty acids and glycerol, leading to endothelial dysfunction and inflammation, further triggering ASCVD. β -glucan is a soluble fiber found in grains and is a low cholesterol compound. Grain β -Dextran absorbs excess cholesterol and TG, increases intestinal viscosity and binds with bile acids, lowering the amount of cholesterol that is circulated in the liver intestinal tract and thereby lowering the chance of atherosclerosis [9]. β -glucan is widely present in grains such as oats and barley. An analysis based on 1120 individuals showed that an intake of β -glucan >3g/day can dramatically lower 0.26 mmol/l of the fasting serum LDL-C and 0.27 mmol/l of TC in those with moderate hypercholesterolemia [10]. On the other hand, LDL-C is believed to increase the risk of CVD. This result also confirms the preventive effect of whole grains on cardiovascular disease. A meta-analysis (9 prospective cohort studies, n= 782,751) showed that the CVD-specific mortality decreased by 8% for each additional 30g of whole grains daily [11].

3.3. Sugar

CVD risk can be increased through the high sugar diet associated with triglyceride (TD), high density lipoprotein (HDL), BMI, waist circumference and fasting glucose. In an American diet, sugar-sweetened drinks are thought to be the main source of added sugar [12]. Higher fructose intake is shown to increase LDL particles in both adults and children. The possible mechanism is to increase the synthesis of hepatic triglyceride and the secretion of very low-density lipoprotein triglycerides by generating new fats to convert fructose carbon into fatty acids, while enhancing the appearance of triglyceride circulation [12]. But the mechanism between excessive fructose intake and the risk of CVD is not yet clear. A research has found that compared to those who consume ≥ 2 servings of sugar-sweetened drinks daily, those who do not consume sugar-sweetened drinks regularly have a 31% lower risk of dying from CVD [13].

3.4. Vegetables and Fruits

Vegetables and fruits can lower serum total cholesterol, reduce consumption of processed meat, saturated fat and low-density lipoprotein (LDL). Fiber and polyphenols in fruits and vegetables can delay atherosclerosis and reduce platelet aggregation, regulate blood lipid levels and lower blood pressure [14]. And magnesium in vegetables and fruits can reduce the production of oxygen free radicals in polymorphonuclear cells, reduce inflammation by reducing cell oxidation, anti-inflammatory mediators such as NO, lipoprotein, lysin, and protectants, thereby reducing the risk of cardiovascular disease [15]. These changes are believed to improve cardiovascular health. A research has claimed that daily intake of 5 servings of vegetables and fruits can decrease the possibility of CVD [14]. Another research uses plant based diet index (PDI) to evaluate the effect of plant-based diet on CVD and finds that Higher PDI compliance reduces CVD risk by 16% and CVD mortality risk by 31% [16].

4. Community Healthcare for Low-income People

Community healthcare professionals are considered to be the most effective advocates for dietary therapy and improving diet quality. With the support of the government, registered dietitians, community doctors and even community pharmacists can provide easily accessible dietary consultation and advice to low-income people. The community can provide these low-income people with help that is suitable for their cultural background, economic status, and language convenience, filling the service gap of large public medical institutions such as state hospitals. Relevant studies have pointed out that community pharmacists and doctors mainly play two types of prevention and control: primary prevention (reducing the prevalence of disease through changing controllable factors such as eating habits) and secondary protection (preventing the recurrence of diagnosed patients through program development) or worsening of the condition). There are three main forms of community help: client-centered long-term counseling, group counseling, and culinary medicine guidance [17].

The survey found that most people are satisfied with the services of community pharmacists and community doctors (10 out of 11 studies, patients were satisfied with the services of community pharmacists.), and believe that their nutritional counseling is effective in CVD prevention and control. Unfortunately, community pharmacists actually serve not many people. We hope to expand the role of community pharmacists in CVD prevention and control, promote anti-inflammatory dietary therapy, and increase relevant consultation opportunities, thereby improving the CVD problem among low- and middle-income people in the United States [18].

Federally Qualified Health Centers (FQHCs) and the Department of Public Health (DPH) have extensive experience working with health workers to generate Community Outreach Strategies for underserved residents. On account of this, we believe that FQHC and DPH can play a leading role in community assistance. Table 2 illustrates the problems and solutions that FQHCs and DPHs may encounter when participating in community services.

Table 2 Issue analysis and solution

Issue	Description	How to work it out
community health workers (CHW) work content	1. Department of Public Health's experience in CHW reaching underserved populations 2. Low-income community residents' distrust of outsiders	1. Focus on providing services to the underserved 2. work with community settings (e.g., community pastor, community pharmacies) FQHC or DPH can hire CHWs from the community such as community pharmacists and family doctors
Special training for CHWs	1. Determine what to cover based on specific communities 2. Select candidates who are local experts in the field	1. Investigate the specific situation of the community in advance (such as the proportion of ethnic minorities and the proportion of religious beliefs) 2. Hire experts to provide targeted training
Long-term counseling and group counseling	1. Lack of consulting services 2. Low-income residents have low educational level 3. Some low-income groups may be accustomed to using dialects or foreign languages and have language barriers.	1. Hire both full-time and part-time CHWs to increase consulting opportunities 2. Limit the time for a single consultation and implement an appointment system 3. Use more colloquial language in consultations and hire CHWs who adapt to the language categories of the community
Community resources	Food and nutrition insecurity and poor diet quality	1. Create an inventory of community resources that support CVD and recommend them to residents 2. Reduce the targeted marketing of unhealthy foods to low-income communities

5. Recommended Diet:Anti-inflammatory Diet

N-3 fatty acids, monounsaturated fatty acids, dietary fiber, magnesium, zinc, vitamins A and D, anthocyanins, flavonoids, etc. are all found in anti-inflammatory foods. Foods high in trans fats, saturated fats, cholesterol, calories, carbs, and protein are frequently considered pro-inflammatory.

The higher the Empirical dietary Inflammatory Pattern (EDIP) score of food,the higher the food's inflammatory index (DII), the higher the risk of cardiovascular disease (curvature test: cardiovascular disease $p=0.002$, CHD $p=0.04$) [19]. Foods are more anti-inflammatory when their DII is lower.For every 1 point decrease in DII score, the risk of CVD and mortality decreases by 8% [20].Therefore, Lowering the diet's inflammatory index (DII) is a useful tactic for both primary and secondary CVD prevention. One common dietary pattern that reduces inflammation is the Mediterranean diet (MD). The "Dietary Guidelines for Americans 2015-2020" considers the MD to be an economically feasible strategy for preventing cardiovascular disease. This eating pattern was first proposed by Angel Keys

in the 1860s based on observations of eating habits in Spain, Italy and other Mediterranean regions. This type of diet includes a large amount of vegetables and fruits, whole grains, appropriate amounts of nuts, beans, seafood and other meat products, uses olive oil as cooking oil and the main source of fat, and is supplemented with garlic and appropriate amounts of red wine during meals (the best effective dose is 150ml/d). This eating pattern reduces the amount of red meat, processed meat, sugary desserts and beverages that low-income Americans tend to overeat.

The PREDIMED study of 7,447 participants found that the incidence of CVD was about 30% lower in the experimental group following the MD than in the control group. This provides a theoretical basis for the primary prevention of CVD with the MD [19]. One study showed that volunteers following MD had significantly lower rates of incident myocardial infarction and stroke during 2-7 years of follow-up, with odds ratios (OR) of 0.62 and 0.63, respectively. MD may significantly reduced CVD mortality (OR 0.54).

From the perspective of an anti-inflammatory diet, the mechanism of action of the MD is to improve blood lipids, insulin sensitivity and endothelial function. Additionally, there are notable antioxidant effects of this food pattern. A major part of the pathophysiology of atherosclerosis is oxidative stress. It affects thrombus formation by promoting atherosclerosis, platelet activation and coagulation cascade. In general, thrombosis may be impacted by the Mediterranean diet's beneficial synergistic effect of several nutrients, which decrease oxidative stress. More specifically, a variety of substances, including vitamin E, quercetin, curcumin, and resveratrol, are abundant in vitamins and antioxidants in Maryland. These compounds have the ability to scavenge free radicals, prevent the adhesion of monocytes, and decrease the oxidation of low-density lipoprotein (LDL), which is a major contributor to atherosclerosis. In addition, the intake of virgin olive oil and wine, which are rich in antioxidant polyphenols, is conducive to the absorption and utilization of unsaturated lipids, especially phospholipids, which have antioxidant properties and have a preventive effect on CVD [21].

A study that monitored metabolites linked to a decreased risk of cardiovascular disease (CVD) showed that the Mediterranean diet's polyunsaturated fatty acid composition helped lessen the risk of cardiovascular disease. Among them, the fish's long-chain omega-3 fatty acids and other seafood, and the monounsaturated fats rich in virgin olive oil have positive effects on the prevention of cardiovascular disease.

6. Conclusion

The unhealthy dietary patterns of low-income individuals are a factor leading to a greater risk of CVD. Because the participation of low-income individuals in prevention counseling or risk factor screening for CVD is relatively low and tend to consume high-fat, refined grains, and a diet with added sugar, which has a higher Dietary Inflammation Index (DII) and may cause the body's level of low-density lipoprotein cholesterol (LDL-C) to rise. Conversely, individuals from low-income backgrounds tend to consume fewer fruits, vegetables, and whole grains, which can help lower the risk of cardiovascular disease because of their positive effects on metabolism, serum cholesterol levels, and anti-inflammatory qualities.

The Mediterranean diet is an effective anti-inflammatory dietary pattern that may lower the risk of cardiovascular disease. It is high in fruits, vegetables, seafood, nuts, legumes, whole grains, and freshly squeezed olive oil. It also minimizes the intake of pro-inflammatory foods. Community assistance programs focused on promoting anti-inflammatory dietary patterns such as Mediterranean diets, along with long-term therapy, group counseling, and culinary medicine advice, may be extremely important in lowering the incidence of CVD in low-income groups. However, regarding the preventive effect of MD on cardiovascular disease, and which type of dietary pattern plays an actual role, there is no good explanation, or different opinions, and the efficacy indicators have not been well quantified, and future research will be required.

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