The Influence of Low-Carbohydrate and Low-Fat Diet on Cardiovascular Disease

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Abstract. It has become a consensus that low fat diet is the key to lose weight and keep slim. This study is important for obese and overweight individuals, who are at increased risk of CVD. The reduction of total fat in food is directly related to the reduction of individual cholesterol level and blood pressure, which also reveals the beneficial role of low-fat diet in preventing the risk of heart problems. Low-carb diets and low-fat diets can both help to lower the risk of CVD, but there's no direct link between them. The basic mechanism is to improve other factors like hypertension and obesity which can be altered by healthy diets. Cutting back on saturated fatty acids can lower heart problems and stroke risk, because less cholesterol and saturated fats re consumed. Therefore, it is essential for us to eat correctly and healthily and take more exercise to prevent happening of CVD.

Keywords: Low-Fat Diet, Low-Carb Diet, Cardiovascular Diseases, Cerebrovascular Diseases.

1. Introduction

With cardiovascular disease being the top causes of death all over the world recently (representing almost 30% of all deaths worldwide), an increasing number of people have paid more attention to the daily diet patterns. There has long been a contentious debate about whether diets may help lower the risk of heart disease. A set of illnesses that affect the blood vessels and the heart are known to it as "CVDs," including hypertension, atherosclerosis, coronary artery diseases, and vein conditions. The primary mechanism for diets to lower the risk of CVD is to get rid of unhealthy habits. Unhealthy dietary patterns and nutrition intake are closely connected with CVD, along with insufficient exercise, obesity, hypertension and alcohol consumption [1]. One of the most controllable factors is obesity, which can be altered by modifying dietary structure. Two dietary patterns: low-carb diet and low-fat diet are becoming popular in recent years to lose weight and in turn help improve health conditions like CVD and other chronic diseases like diabetes and hypertension. However, whether low-carb diets and low-fat diets have direct association with lowered risk of CVD is unclear and controversial among studies. This article will analyze different results of studies to find if there's a positive correlation between low-carb diets, low-fat diets and CVD. Some suggestion on dietary pattern and food choices will also be included.

2. Cardiovascular Disease (CVD)

Cardiovascular disease refers to a group of ailments that affect the heart or blood arteries (CVD). Data have showed that an approximated 17.9 million deaths were attributable to cardiovascular disease and cerebrovascular diseases annually, corresponding to 32% of all fatalities worldwide. The first year following an ischemic stroke has been associated with mortality rates of 7% to 37%, with yearly mortality risks of 5% to 11% and 5-year mortality rates of 53% to 60% [2].

2.1. Coronary Artery Disease (CAD)

The formation of atherosclerotic plaque in the arterial lumen causes CAD, the most prevalent form of heart disease in the country. CAD is typically attributed to the start of the chronic inflammatory process, which gets incited by endothelial dysfunction. When endothelial function of the artery wall is disrupted, atherosclerosis begins as a buildup of droplets of lipoprotein in the coronary artery intima. The earliest form of atherosclerotic lesion is named as a fatty streak, foamy-texture cells that replicate

and form lesions [3]. The formation of these lesions activate signals attracting smooth muscle cells (SMCs), which will then proliferate and produce extracellular matrix (Fig 1). The resulting lesion is a complex, progressive lesion with necrotic material that may be highly thrombogenic and a fibrous cap covering a lipid-rich core.

Risk factors of CAD can be multiple, most of which is modifiable, like smoking, obesity, and lipid levels. Other factors can involve genetics, gender age, and family history. Therefore, lifestyle modification is crucial for CAD prevention and to reduce cardiovascular risk factors, including diet, exercise, and smoking cessation.

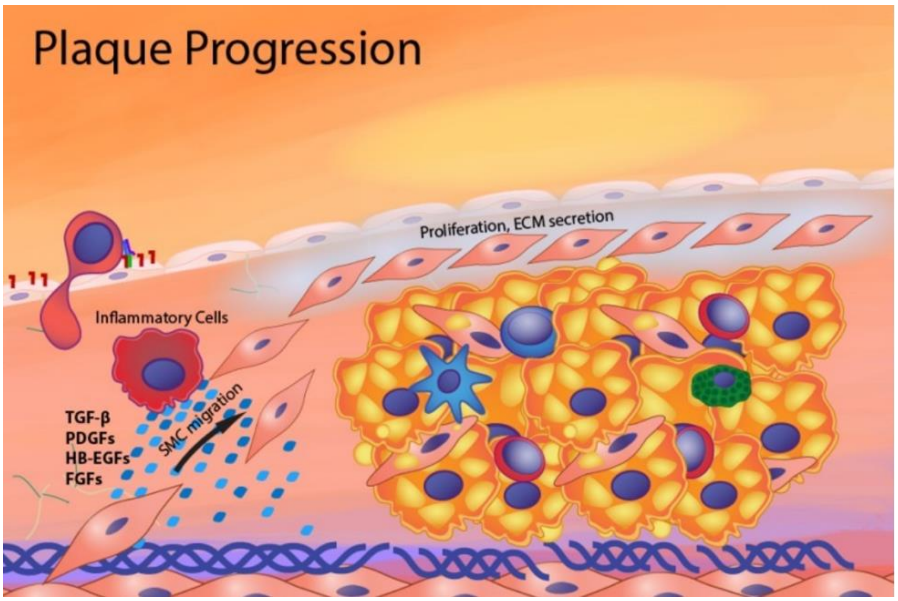


Figure 1. Progression of the atherosclerotic plaque [3]

2.2. Atherosclerosis

Atherosclerosis is a long-term inflammatory condition that causes plaque to accumulate inside the arteries. These plaques are mostly made of lipids, which cause turbulent flow and an inflammatory response, leading to atherosclerotic cardiovascular disease (ASCVD). An early event in the process of atherosclerosis is the retention of invading low-density lipoprotein (LDL) particles on proteoglycans in the subendothelial region. Proteases and lipases biochemically alter the trapped lipoproteins, causing them to aggregate and have higher proteoglycan binding. Oxidized LDL, which is produced by myeloperoxidase, lipoxygenase, and reactive oxygen species, has oxidative changes that might cause an innate inflammatory response. Among the multifactorial etiology of ASCVD, hypercholesterolemia (LDL-cholesterol), hypertension, diabetes mellitus, and smoking are the most prevalent risk factors. It is challenging to precisely estimate the incidence of atherosclerosis, which is thought to be a major contributor to cardiovascular disease but is mostly asymptomatic.

2.3. Hypertension

Systemic arterial hypertension, which is also connected to an extra likelihood of CVD, is the most important modifiable worldwide all-cause mortality risk for morbidity and mortality. Hypertension is common but it’s difficult to determine the incidence. It’s easy to be ignored especially by young people which makes it one of the main causes of cardiovascular and cerebrovascular diseases. Hypertensive heart disease results from chronic high blood pressure. About one-fourth of all heart failure causes are caused by hypertensive heart disease. Myocardial structural and functional alterations are brought on by hypertension, which increases the burden placed on the heart. These modifications include hypertrophy of the left ventricle, which can lead to heart failure. Left ventricular hypertrophy significantly increases the morbidity and mortality of the patients. The etiology of hypertension is poorly understood, however, the complicated interaction between genetic

and environmental variables is probably to blame. Age, family medical history, obesity, high sodium diets (more than 3g/day), and binge drinking are a few risk factors that are significantly and independently associated with the onset of hypertension [4].

2.4. Susceptible Population

Obesity raises the risk of cardiovascular disease (CVD), especially heart failure and coronary artery disease (CAD). Through a variety of factors, including alterations to physical performance that could have an impact on hemodynamics and modify the anatomy of the heart, obesity raises the risk of CVD. There's a variety of ways to being obese, among which high sugar and high carbohydrate diet are of the real culprit. High sugar consumption has been associated with an elevated danger of metabolic syndrome and CVD, depending on the amount of carbohydrate (CHO), other nutrients in meals, and preexisting metabolic abnormalities. Additionally, substituting dietary fat with CHO of varied quality has been linked to an increased risk of CVD, mostly as a result of a rise in plasma triglycerides (TG) and a fall in plasma high density lipoprotein (HDL).

2.5. Risk Factors of CVD

Broadly speaking, stroke risk factors include atrial fibrillation, elevated blood pressure, diabetes, tobacco use, and obesity, and medication usage. Atherosclerosis and other metabolic problems including insulin resistance and hypertension are all linked to a high-calorie diet, saturated fats, and sweets. These conditions are rather common in persons with CVD. Therefore, changes of dietary patterns such as salt restriction, a balanced diet, and weight loss are really helpful in decreasing the blood pressure, which can in turn prevent the happening of stroke and cardiovascular diseases [5].

3. Low-Carb Diets

3.1. Carbohydrates

Along with protein and fat, carbohydrates are among the three main macronutrients that comprise the human diet. They are categorized into a variety of groups, such as sugars, starches, and fibres, depending on how many sugar units there are and how chemically connected they are to one another. They provide energy, assist in regulating insulin and blood sugar metabolism, and take part in the metabolism of cholesterol and triglycerides.

3.2. Definition

These is no clear consensus what is a LCD, and the definition of it varies between studies. The LCD is now widely defined by the fraction of total daily calories that come from carbs (<20%). Lipids (55-75%) and protein (25-30%) account for a disproportionately large share of daily calorie consumption [6]. The fact that fats and protein promote satiety and cause less concomitant hypoglycemia is one theory as to why low-carb methods to weight management result in quick weight loss when compared to other diets. The decrease in appetite and overall food intake brought on by this rise in satiety and lessening of rebound hypoglycemia results in a calorie deficit [7].

3.3. Influence on CVD

The effects of low-carb diets on cardiovascular disease have long been controversial and the results of studies are inconsistent. However, a general trend can be summarized through a meta-analysis (Fig 2) [8]. According to the findings of this meta-analysis, low-carbohydrate diets generally had favourable effects on CVD risk variables when compared to the impacts of a control diet between 6 and 11 months and less than 6 months; however, beyond 2 years, these effects were minor [8]. Increased percentage of fat consumption in low-carb diets can be worrying, due to the detrimental effects that "bad" fats on human body like saturated fats and trans fats. However, research have suggested that diets richer in protein and fat and lower in carbohydrates are not linked to a greater

likelihood of CVD, particularly coronary heart disease. When plant-based forms of fat and protein are used in these diets, there may be a slight reduction in the risk of developing coronary heart disease. The direct association between low-carb diets and CVD is slight, but the low-carb diets can indeed have a beneficial influence on CVD by improving other factors like losing weight. Despite the fact that low-carb diets reduce CVD risk factors, additional study is needed to determine the long-term implications [8].

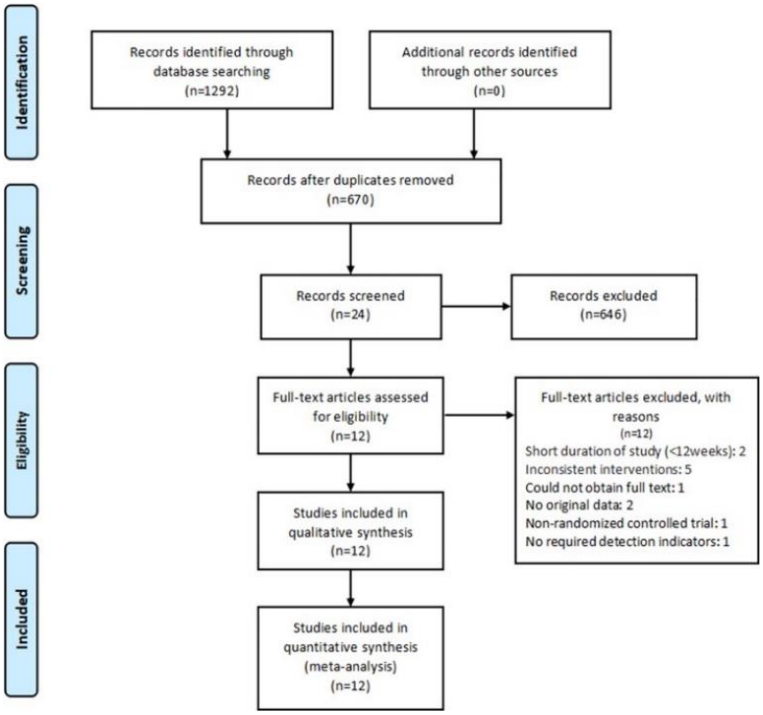


Figure 2. Flowchart of the meta-analysis [8]

3.4. Side Effects of Low-Carb Diets

When carbohydrate intake is insufficient, in addition to the energy provided by protein, it will also lead to body lipolysis. Although it results in weight loss, it causes the extra synthesis of ketone bodies in the liver, which is likely to cause Ketoacidosis when it exceeds certain amount.

4. Low-Fat Diet

The Low-Fat Diet varies significantly from the Low-Carbohydrate Diet in that only 20–30% of daily calories come from dietary fats, whereas 55–65% come from carbs and 15-20% come from protein.

4.1. Fats (Lipids)

Lipids represent a category of polar and nonpolar molecules, and contribute to the flavour, texture, and energy content of food. In addition to assisting in the absorption of fat-soluble vitamins and other dietary components, lipids in the body may be employed as readily available and stored energy, a part that is both structural and functional for all cell membranes, and a precursor for eicosanoids and cell signalling molecules [9].

4.2. Dietary Fats Selection

It seems that fats play an really essential role in functioning our body, however, the choice of types of dietary fats can play a decisive role in whether it will linked to an increased risk of heart diseases and inflammatory diseases. There are many types of fats in our body: triglycerides, saturated and unsaturated fats, cholesterol, and trans-fats. All these fats play an essential role in maintaining the

normal functioning of our body, but too much fat can be harmful and raise the chance of heart problems, type 2 diabetes, hypertension, and blood clotting. It's necessary that the appropriate amount and right type of fats be consumed

4.2.1 Saturated Fat

It is well recognized that saturated fatty acids (SFA), a substantial risk factor for CVD, raise LDL cholesterol. Saturated fats and an increased risk of CVD, however, have not been proven to be causally related in recent investigations. The results of the research have shown that there's no obvious reduction of risks of CVD when consumption of saturated fats is restricted. This might because lowered saturated fats consumption always leads to a higher amount refined carbohydrate, which is also detrimental to our cardiovascular health. It's acknowledged that lower the amount of saturated fat will decrease LDL level in the body and in turn lower the risk of CVD, but its direct association with heart disease, atherosclerosis and cerebrovascular diseases remains unclear.

4.2.2 Trans Fats

Trans fats are another risk factors to cause CVD. Trans fat decreases healthy high density lipoproteins (HDL) while raising levels of LDL, triglycerides, and insulin level. This results in a less desirable LDL/HDL ratio, which increased the risk of CVD. The World Health Organization (WHO) and the Food and Agriculture Organization (FAO) of the United Nations made the recommendation that trans-fat acids (TFA) levels in dietary fats for humans be decreased to less than 4% [10].

4.2.3 Cholesterol

Although cholesterol is necessary for many healthy cell activities, the body may suffer injury if aberrant blood concentrations are allowed to grow. The risk of developing early atherosclerotic cardiovascular diseases (ASCVD) rises when LDL-cholesterol levels are excessively high, a condition known as hypercholesterolemia. Research also indicates that young individuals who had high cholesterol levels also had a higher chance of developing CVD [11]. The condition known as atherosclerosis, a kind of heart disease, is brought on by the buildup of cholesterol in the artery walls that occurs when blood cholesterol levels are too high.

4.3. Influence on CVD

Dietary fat consumption and cardiovascular disease have a direct causal link according to current research. Saturated fat and cholesterol-rich diets have been demonstrated to accelerate atherosclerosis progression. Recent research on secondary prevention have found that a Mediterranean-style diet or a very low-fat diet prevented recurrences, and meta-analyses of recent lipid-lowering pharmaceutical trials revealed a significant correlation exists between variations in LDL-C levels and a reduced prevalence of CAD [12].

5. Suggestions for Susceptible Population

A balanced diet pattern is exceedingly important to lower the risk of getting CVD and other kinds of diseases. The Mediterranean diet is mostly plant-based, with fish, chicken, and a small amount of dairy products making up the majority of the animal-based foods. Although the modern diet includes a greater percentage of processed foods and red meat, its major emphasis on plant-based foods and healthy fats remains the same (Fig 3) [13]. According to the "Seven Countries Study," those who follow a Mediterranean diet had considerably lower cardiovascular disease risks and overall lower rates of the condition [13].

To be specific, for carbohydrate consumption, whole grains and dietary fiber are high suggested to appear in meals. According to the Healthy Eating Plate, it's better to fill up the majority of the plate with healthy carbs, with vegetables (apart from potatoes) and fruits making up approximately half of it and whole grains making up about a fourth. As for fats, the main point here is to choose the healthy fat like unsaturated fat, while avoid excess amount of bad fats like trans-fat and saturated fats. As

seen in Fig 3, saturated fats and trans fats can both increase LDL cholesterol level, which is harmful to our body and can increased risks of CVD. Sources of these types of fat and other detailed information like intake recommendations can also be found in Fig 4.

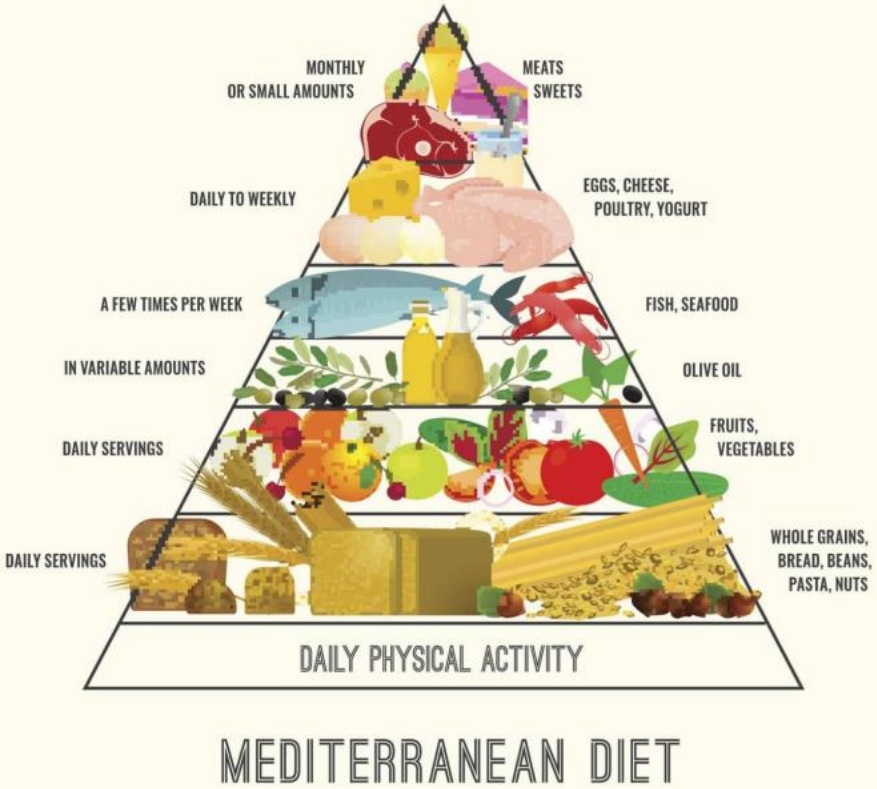


Figure 3. Mediterranean diet pyramid

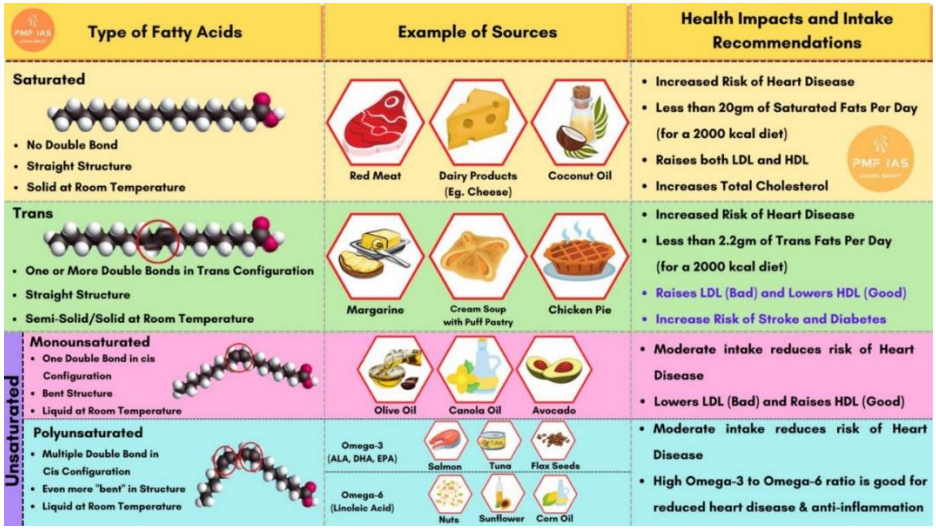


Figure 4. Structure, sources, and intake recommendations of different kinds of fats [14]

6. Conclusion

Low-carb diets and low-fat diets can both help to lower the risk of CVD, but there's no direct link between them. None of the research has demonstrated that low-carb diets and low-fat diet can directly improve CVD. The basic mechanism is to improve other factors like hypertension and obesity which can be altered by healthy diets. The recommended dietary structure is to eat less saturated fats and trans-fat, more cereals, fruits and vegetables. What's more, controlling body weight and frequent

exercise are also key factors to avoid CVD. All in all, it's highly suggested that a balanced diet and healthy lifestyle be kept to avoid the risk of CVD.

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