

The Preventive and Therapeutic Effects of the ‘Jiangnan Dietary Pattern’ on Hyperlipidemia in Adults

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Abstract. In recent years, the prevalence of hyperlipidemia in adults has remained high, and it has become a major risk factor for cardiovascular diseases such as atherosclerosis. Dietary intervention has attracted much attention as an important way to improve hyperlipidemia. At present, dietary patterns such as the Mediterranean diet have been proven to have the effect of regulating blood lipids, and the Jiangnan diet pattern, which conforms to the dietary habits of Chinese residents and has regional characteristics, has gradually attracted attention due to its role in preventing and treating hyperlipidemia. This article analyzes the nutritional characteristics of the Jiangnan diet, which is rich in dietary fiber, ω -3 polyunsaturated fatty acids, and flavonoids, and explores its preventive and therapeutic effects on hyperlipidemia through mechanisms such as regulating lipid metabolism, improving intestinal flora, and anti-oxidative stress. In patients with hyperlipidemia, clinical research has demonstrated that Jiangnan dietary intervention can successfully lower triglyceride, low-density lipoprotein cholesterol (LDL-C), and total cholesterol levels. However, existing studies still have problems such as sample limitations. In the future, the long-term intervention effect and personalized application strategy of the Jiangnan diet can be further explored.

Keywords: Jiangnan dietary pattern, hyperlipidemia, nutritional characteristic

1. Introduction

Hyperlipidemia refers to elevated triglycerides (TG) and/or total cholesterol (TC) in the plasma, elevated low-density lipoprotein cholesterol (LDL-C), and decreased high-density lipoprotein cholesterol (HDL-C). It is abnormal fat metabolism or transportation that causes the lipid content in human blood to exceed the normal range. A recent research survey shows that the prevalence of dyslipidemia among adults is 38.1%, among which the main type is hyperlipidemia caused by low HDL-C and high TG, but its control rate is only 3.53% [1]. The most prevalent kind of dyslipidemia, it is a significant risk factor for many chronic conditions, such as atherosclerosis and atherosclerotic cardiovascular disease (ASCVD), which can lead to heart failure, arrhythmia, coronary heart disease, myocardial hypertrophy, and myocardial infarction. The health and well-being of humans are greatly impacted by these cardiovascular disorders [2]. At present, in addition to drug treatment, an increasing number of studies have shown that diet is one of the keys to improving hyperlipidemia in adults, such as the Mediterranean diet, DASH diet, and vegetarian diet, etc. At every evaluation,

MedDietScore was used to measure adherence to the Mediterranean diet, and WHO-ICD-10 was used to measure hypercholesterolemia. It was discovered that a high level of long-term adherence to the Mediterranean diet averted about 30% of cases of hypercholesterolemia. Adult ATTICA prospective cohort trial participants who were initially free of CVD made up the sample [3]. The Mediterranean diet is characterized by a focus on plant-based foods, accompanied by moderate amounts of fish, poultry, low-fat milk, olive oil, a small amount of red meat, and a moderate amount of red wine. However, due to its unique geographical environment, the Mediterranean diet is not the most comfortable and suitable for Chinese people to consume. Therefore, the usage frequency of the Jiangnan diet is gradually increasing.

At present, the Jiangnan Dietary Pattern in our country has attracted widespread attention. The Jiangnan region is characterized by its mountains, warm water, mild climate and abundant products. In the past, its diet was mainly composed of "a large amount of fresh fruits and vegetables, fish, shrimp and soy protein, vegetable oil such as rapeseed oil, and unprocessed carbohydrates such as brown rice". Combined with the cooking methods of "preference for steaming and boiling, light and low-salt, small portions and diverse choices", a dietary pattern with distinct regional characteristics was formed [4]. However, at present, there are still relatively few direct studies on the relationship between the Jiangnan dietary pattern and hyperlipidemia in adults. Therefore, this article intends to summarize the improvement effect of the Jiangnan dietary pattern on adult patients with hyperlipidemia and provide a reference basis for the dietary pattern.

2. The nutritional characteristics and main components of Jiangnan cuisine

The "Jiangnan Dietary Pattern" was mentioned for the first time, and it was pointed out that this dietary pattern is "the healthiest dietary pattern in China" and is suitable for wide promotion [4]. The Jiangnan cuisine originated in the middle and lower reaches of the Yangtze River. It mainly consists of rice, supplemented by whole grains (brown rice, oats), miscellaneous beans (red beans, mung beans) and tubers, and is rich in dietary fiber and resistant starch. Because the Jiangnan region is mostly coastal, over 30% of its main protein sources are aquatic products, making it an excellent source of omega-3 polyunsaturated fatty acids (EPA, DHA). Soy products (tofu, soy milk) provide plant protein and soy sterols. The Jiangnan region is rich in green leafy vegetables (such as Chinese cabbage and shepherd's purse), aquatic vegetables and citrus fruits throughout the four seasons, which are rich in dietary fiber, vitamin C, flavonoids and other nutrients. The dishes are mainly steamed, blanched and stir-fried, with a reduction in fried and pickled foods. The amount of salt used is lower than the national average. Natural spices such as ginger, garlic and scallions are often used to replace high-sodium seasonings, which helps control blood pressure and indirectly improve lipid metabolism.

2.1. Dietary fiber

Dietary fiber, or DF, is thought to be the seventh-most important nutrient and is essential to preserving human health. Human digestive enzymes are unable to break down dietary fiber, which is a non-starch polysaccharide. Lignin, a non-carbohydrate component, is included in these polysaccharides along with cellulose, hemicellulose, pectin, gums, and mucilage [5]. The effects of dietary fiber on the human body include: increasing the volume of intestinal contents, promoting intestinal peristalsis, accelerating the excretion of food residues, and reducing the retention time of harmful substances in the intestines. It forms sticky substances in the intestines, hindering the absorption of cholesterol and fat, thereby reducing cholesterol levels. According to randomized

controlled trials, soluble fiber included in oat products lowers blood cholesterol levels, particularly low-density lipoprotein (LDL) cholesterol, in patients with hypercholesterolemia [6]. Brown et al. assessed the hypocholesterolemic effects of oat bran, guar gum, pectin, and psyllium in a meta-analysis of 67 controlled studies. These authors found that although there were no appreciable changes in the amounts of triglycerides or HDL cholesterol in plasma, all of those soluble fibers were equally efficient in lowering LDL and total cholesterol. Moreover, dietary fiber can delay the digestion and absorption of carbohydrates, making the increase in blood sugar moderate and helping to stabilize blood sugar. Provide nutrients for beneficial bacteria in the intestines, regulate the balance of intestinal flora, and enhance the function of the intestinal barrier. Dietary fiber promotes the proliferation of beneficial bacteria such as *Bifidobacterium* and *Lactobacillus* by providing substrates for beneficial bacteria, regulating metabolic products and the intestinal environment, while inhibiting harmful bacteria. Ultimately, it enhances intestinal health through pathways such as short-chain fatty acids and the mucus barrier. Different types of dietary fiber (such as inulin and resistant starch) have certain specificity in regulating the microbiota, and their effects are related to the intake and the baseline of the individual microbiota.

2.2. Omega-3 polyunsaturated fatty acids (ω -3 PUFA)

Omega-3 polyunsaturated fatty acids have the functions of reducing triglycerides, protecting the cardiovascular system, promoting the development of the brain and nervous system, and anti-inflammation. ω -3 PUFAs are incorporated in phospholipids of plasma membranes of different cell types including erythrocytes, neutrophils, and platelets. The addition of ω -3 PUFAs to membrane phospholipids improves the fluidity and biophysical aspects of the membrane via altering the characteristics of lipid rafts and caveolae. The production of certain cytokines and acute-phase reactants (interleukin-1, interleukin-6, and C-reactive protein) with strong anti-inflammatory properties is finally reduced as a result of ω -3 PUFAs' structural effects on cell membranes as well as their specific and direct binding to membrane proteins. ω -3 PUFAs may have their last anti-inflammatory and anti-atherosclerotic effects because they produce a number of bioactive metabolites known as " ω -3 oxylipins" [7].

2.3. Flavonoids

Flavonoids have multiple positive effects on the human body. It has antioxidant effects, can eliminate free radicals in the body, reduce oxidative damage, and help prevent chronic diseases such as cardiovascular diseases and cancer. It can also regulate blood lipids, lower cholesterol and triglyceride levels, inhibit platelet aggregation, improve vascular endothelial function, and thereby maintain cardiovascular health. In addition, it has anti-inflammatory properties, which can reduce the body's inflammatory response and has a certain alleviating effect on some inflammation-related diseases. At the same time, it also plays an important role in antibacterial, antiviral and nervous system protection, and is of great significance for improving the overall health of the human body. A study shows that the anti-inflammatory qualities of the flavonoids in *Pueraria lobata* have a broad-ranging impact that involves molecular mechanisms and immune cell regulation [8]. By regulating other immune cells, limiting neutrophil infiltration, affecting T-cell homeostasis, and managing macrophage polarization and phagocytosis, they play a crucial role in the anti-inflammatory process at the immune cell level. Moreover, at the molecular level, the inflammatory process is modulated through the regulation of inflammatory cytokine and mediator release, the modulation of signaling pathways the regulation of miRNA expression, and the modulation of intestinal microbiota.

Research on the anti-inflammatory mechanisms of flavonoids in *Pueraria lobata* has elucidated their multi-target and multi-level regulatory actions, while highlighting the unique contribution that dietary and medical resources make to the management and prevention of inflammatory diseases.

3. The clinical therapeutic effect of the Jiangnan dietary pattern on hyperlipidemi

Jiangnan dietary pattern prevents and treats hyperlipidemia by regulating lipid metabolism. Hyperlipidemia can be brought on by triglycerides (TG) and/or total cholesterol (TC), increased low-density lipoprotein cholesterol (LDL-C), and decreased high-density lipoprotein cholesterol (HDL-C). A study involving 253 adults showed that after 6 months of intervention with the Jiangnan diet, the participants' total cholesterol, LDL-C and triglycerides decreased by an average of 0.22, 0.24 and 0.27 mmol/L, respectively [9].

Patients with hyperlipidemia will have multiple metabolic pathways affected. Firstly, there is the lipid metabolism pathway. Abnormal lipid components in the plasma can interfere with the synthesis, decomposition and transport processes of fats, such as β -oxidation of fatty acids, assembly of triglycerides and metabolism of lipoproteins, etc. At the same time, the inflammatory response pathway is activated, leading to the release of inflammatory factors, triggering chronic inflammation and further affecting the function of vascular endothelial cells. Oxidative stress pathways can also become imbalanced, generating excessive free radicals that damage cells and tissues. In addition, the insulin signaling pathway may be disrupted, affecting glucose metabolism, leading to insulin resistance, which in turn causes an imbalance in blood sugar regulation and aggravates metabolic disorders.

The dietary fiber in the Jiangnan dietary pattern can combine with intestinal cholesterol and promote its excretion, reducing the synthesis of endogenous cholesterol. High-quality protein (such as omega-3 polyunsaturated fatty acids rich in fish) can lower triglyceride levels, increase HDL content, and promote the reverse transport of cholesterol. Low intake of saturated fat reduces the liver's synthesis of LDL and lowers the concentration of LDL in the blood. The phytochemicals such as tea polyphenols and flavonoids in fruits and vegetables can also inhibit the activity of lipase, reduce lipid absorption, improve insulin resistance, and thereby optimize lipid metabolism as a whole and lower the risk of hyperlipidemia. Among them, HDL mainly transports excess cholesterol from peripheral tissues (such as the arterial wall) back to the liver for metabolism and excretion through the "reverse cholesterol transport" mechanism. The apolipoproteins it contains (such as ApoA-1) can also inhibit inflammation and oxidative stress and protect the vascular endothelium. LDL is responsible for transporting cholesterol synthesized by the liver to peripheral tissues. If the level of LDL in the blood is too high, it is prone to oxidation to form oxidized LDL, which promotes the deposition of cholesterol on the arterial walls, triggers inflammatory responses, induces the formation of foam cells, and thereby promotes the formation of atherosclerotic plaques, increasing the risk of cardiovascular diseases.

4. The mechanism of the Jiangnan dietary pattern in improving hyperlipidemia

4.1. Jiangnan dietary pattern prevents and treats hyperlipidemia by improving the intestinal flora

The intestinal flora can regulate lipid metabolism by metabolizing dietary fiber to produce short-chain fatty acids, alter the enterohepatic circulation of bile acids, disrupt the intestinal mucosal barrier to trigger inflammatory responses, and influence the secretion of intestinal hormones, thereby

promoting or inhibiting the occurrence and development of hyperlipidemia. More and more evidence indicates that dietary factors play a crucial role in shaping the gut microbiota. The moderate amounts of fish, nuts and tea in the Jiangnan dietary pattern are rich in omega-3 fatty acids and polyphenols, which can inhibit the excessive growth of harmful bacteria (such as Enterobacteriaceae), reduce the release of endotoxins and lower intestinal permeability. According to animal research, ω -3 PUFAs significantly alter the composition of the microbiota by slowing the growth of Enterobacteria and promoting the proliferation of Bifidobacteria. Numerous fatty acid-producing bacteria increased after taking ω -3 PUFA supplements for eight weeks in a randomized study including healthy individuals [7]. Meanwhile, the high dietary fiber content in rice and whole grains provides high-quality prebiotics for beneficial bacteria in the intestines, promoting the proliferation of beneficial bacterial colonies and optimizing the intestinal microecology. Bifidobacteria help break down complex carbohydrates in food, produce short-chain fatty acids and protect the intestinal barrier. Lactic acid bacteria can inhibit harmful bacteria by lowering the pH value of the intestinal tract, secrete digestive enzymes to promote nutrient absorption, stimulate the immune system to enhance immunity, and regulate cholesterol metabolism, etc. However, recent studies have also shown that 50 Danish adult men and women (including those of normal weight and obese) who consumed whole grain foods for 16 consecutive weeks all experienced weight loss and a decrease in inflammatory factors (such as IL-6 and CRP), but there were no significant changes in their gut microbiota diversity, gut microbiota function, and insulin sensitivity. Therefore, when it comes to the relationship and mechanism of action between similar foods and the diversity of gut microbiota, many other factors need to be taken into consideration [10].

4.2. Jiangnan dietary pattern prevents and treats hyperlipidemia by improving oxidative stress

Oxidative stress is the foundation for the development of hyperlipidemia and its complications. When the oxidative stress response mechanism in the human body is activated, fat metabolism disorders occur, the lipid accumulation process begins, and blood circulation is obstructed, which in turn leads to the occurrence of hyperlipidemia. The fresh fruits and vegetables (such as green leafy vegetables and citrus fruits) and tea rich in the model are excellent sources of antioxidants such as flavonoids, polyphenols (catechins), vitamin C and E, which can directly eliminate reactive oxygen species (ROS) such as superoxide anions and free radicals, and reduce the oxidative modification of low-density lipoprotein (LDL). Additionally, they are essential in pharmacological, medicinal, cosmetic, and nutraceutical uses due to their bioactivity and regulatory effects on enzymes like phosphoinositide 3-kinase, cyclo-oxygenase, lipoxygenase, acetylcholinesterase, and xanthine oxidase [11].

5. Discussion

The Jiangnan dietary pattern is characterized by "three lows and two highs" (low salt, low fat, low sugar, high fruits and vegetables, and high aquatic products), and it plays a preventive and therapeutic role in adult hyperlipidemia through a multi-target mechanism. Many studies have shown that its components act simultaneously in various parts and organs of the body, effectively reducing the incidence of hyperlipidemia. However, at present, there are not many studies specifically on the Jiangnan dietary pattern suitable for Chinese people to consume, and the Jiangnan diet also has some drawbacks. One is high sugar content. People in the south have a preference for sweet foods. Besides desserts and beverages, when cooking, whether steaming, stir-frying or making soup, they always like to add a little sugar to enhance the freshness. Second,

although the consumption of oil and salt is less than that in the north, it still exceeds the relevant recommended intake in the dietary guidelines. Thirdly, in traditional Jiangnan cuisine, carbohydrates were mainly composed of coarse grains and brown rice. However, in the past three or four decades, significant changes have occurred, with the proportion of refined rice and white flour increasing [12]. Chinese people can adjust their dietary patterns on the basis of giving full play to the advantages of Jiangnan cuisine and strive to create an "improved version" of Jiangnan cuisine. For instance, on the basis of retaining the rich fish and shrimp and light cooking characteristics of Jiangnan cuisine, breakfast can replace part of the white porridge and fried dough sticks with mixed grain porridge and whole wheat steamed buns. For lunch and dinner, green leafy vegetables and mushrooms should account for at least half of each meal. Use steamed sea bass and blanched shrimp instead of braised and fried ones. When making soup on weekends, add traditional ingredients such as water chestnuts and lotus seeds. Using traditional sweet ingredients such as sugar osmanthus and preserved plums for seasoning, reduce the use of refined sugar, and arrange 2-3 nut snacks like walnuts and cashews per week to make the improvement more easily integrated into daily life. The Jiangnan dietary pattern has great potential value in improving diseases such as hyperlipidemia and requires further clinical research.

6. Conclusion

This article focuses on the preventive and therapeutic effects of the Jiangnan dietary pattern on hyperlipidemia in adults, analyzes its nutritional characteristics, and is rich in dietary fiber, omega-3 PUFAs, flavonoids and other components. It can promote the excretion of cholesterol by regulating lipid metabolism, such as dietary fiber. Fish omega-3 fatty acids can lower triglycerides. By improving the intestinal flora, it provides prebiotics for beneficial bacteria and inhibits harmful bacteria. By improving oxidative stress and eliminating free radicals and other mechanisms, it plays a role in preventing and treating hyperlipidemia. Clinical studies have shown that the intervention of the Jiangnan diet can reduce the levels of total cholesterol, LDL-C and triglycerides in participants.

This article confirms the multi-target improvement effect of Jiangnan diet on hyperlipidemia, providing a theoretical reference for the optimization of dietary patterns suitable for the Chinese population. However, at present, there are relatively few related studies, and the Jiangnan diet has drawbacks such as high sugar content, excessive oil and salt, and an increasing proportion of refined rice and white flour with the development of The Times. In the future, it is possible to further explore its long-term intervention effect and personalized application strategies, and promote the clinical application of Jiangnan diet in the prevention and treatment of hyperlipidemia.

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