

A Study of the Effects of Different Dietary Patterns in Elderly Patients With Chronic Obstructive Pulmonary Disease

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ABSTRACT

Chronic obstructive pulmonary disease (COPD) is a respiratory disease characterized by persistent airflow limitation and is a respiratory disease with a high incidence in the elderly population, and its etiology is closely related to smoking, environmental pollution and genetic factors. This study aims to integrate the evidence-based evidence of Mediterranean diet, DASH diet and low-carbohydrate diet, analyze their anti-inflammatory, antioxidant and metabolic regulatory mechanisms, and provide a basis for clinical formulation of individualized nutritional strategies. Based on the PICO principle, we systematically searched the relevant literature of CNKI, VIP, PubMed and other databases from 2015 to 2024, and screened and extracted the data according to the PRISMA guidelines, and explored the effects of different dietary patterns on lung function (FEV1/FVC), inflammatory markers (CRP, IL-6) and quality of life (SGRQ score). The Mediterranean diet greatly improved lung function and reduced the likelihood of exacerbations; The DASH diet can reduce systolic blood pressure in patients with hypertension, but it is not effective in treating patients with very severe COPD; The short-term use of low-carbohydrate diet can correct hypercapnia, but the long-term use of low-carbohydrate diet will increase the risk of weight loss. Mediterranean diet and DASH diet can be used as a first-level intervention program in the stable phase of COPD in the elderly, and a low-carbohydrate diet can be used for short-term management of acute exacerbations.

KEYWORDS

Chronic Obstructive Pulmonary Diseases; Dietary Patterns; Nutritional Intervention; Elderly Patients

1 Introduction

(1) Background:

Chronic obstructive pulmonary disease (COPD) is one of the most common respiratory diseases. The cause of its pathogenesis is the result of the long-term interaction between a variety of environmental factors and the body's own factors. Refractory to cure and prone to recurrence. The three main risk factors are smoking, environment, and genetics^[1]Smoking is a core pathogen of COPD, and active smoking or exposure to secondhand smoke can cause oxidative stress and protease-antiprotease imbalances that can lead to structural destruction of the lungs^[2]; From an environmental perspective, long-term exposure to biofuel smoke, occupational dust, and air pollutants such as PM2.5 and NO2 can accelerate the decline of lung function^[3]; Genetic factors include α -1 antitrypsin deficiency^[4]and specific gene polymorphisms^[5]Such examples are representative.

According to statistics^[6]About 3 million people worldwide suffer from COPD every year, which is the fourth leading cause of death in China, with more than 1 million deaths per year, and the prevalence rate of people over 60 years old exceeds 27%^[7], the patient is accompanied by cough, wheezing, dyspnea and other manifestations, which seriously affects the quality of life of the patient. With the intensification of China's aging population, the number of patients is gradually increasing^[8]. The superposition of factors such as increased energy expenditure and loss of appetite due to dyspnea in elderly COPD patients leads to a significant increase in the risk of malnutrition. The mechanism involves multi-factor interactions: increased work of respiratory muscles can increase the consumption of resting energy; Chronic systemic inflammation further accelerates protein catabolism; Gastrointestinal dysfunction results in nutrient intake.

The Global Initiative for Chronic Obstructive Pulmonary Disease (GOLD 2023) advocates regular nutritional assessment for moderate to severe patients, and prioritizes the use of a high-calorie, high-protein diet combined with antioxidants (such as vitamins C and E) to promote muscle metabolism optimization; According to the Chinese Guidelines for the Nutritional Management of Chronic Respiratory Diseases, elderly patients with impaired swallowing function should be treated with an individualized meal system and oral nutritional supplementation. Research shows^[9]Dietary patterns such as the Mediterranean diet and DASH diet have been applied to COPD studies, and preliminary results have shown that dietary patterns are potentially associated with symptom improvement, inflammation and lung function preservation in elderly COPD patients, so dietary care should be implemented for elderly COPD patients to promote the improvement of lung function, quality of life and nutritional level.

(2) Objectives and Significance:

Based on a systematic review, this study showed the different effects and co-mechanisms of the Mediterranean diet,

DASH diet and low-carbohydrate diet on elderly COPD patients, and the three dietary patterns all improved lung function and quality of life by inhibiting inflammatory pathways, resisting oxidative stress and regulating metabolic homeostasis, which is very consistent with the core pathological mechanisms of COPD - chronic inflammation and oxidative stress. The innovation of this study lies in the fact that this study systematically compares the effects of the three dietary patterns for the first time, integrates the core components of the Mediterranean diet, DASH diet and low-carbohydrate diet, and proposes a "hierarchical intervention strategy" through comparative analysis of the differences in their nutritional composition. The limitation lies in the lack of data in Asian populations, especially the long-term safety of low-carb diets for elderly Asian patients with COPD, which still needs to be verified. Direct evidence of the synergistic effect of dietary patterns with pulmonary rehabilitation programmers (e.g., exercise training) is lacking. At the same time, this study deeply analyzed the effects of Mediterranean diet, DASH diet and low-carbohydrate diet on elderly patients with COPD, analyzed the mechanism of action, clinical effects and limitations of different dietary patterns, and provided theoretical basis and practical guidance for personalized nutritional intervention.

2 Types of eating patterns

Current research generally suggests that dietary patterns can affect COPD progression and prognosis by regulating inflammation, oxidative stress, and metabolic homeostasis. Based on the correlation between nutritional components and pathological mechanisms, the main dietary patterns explored include: Mediterranean diet, DASH diet and low-carbohydrate diet.

(1) Mediterranean diet

The Mediterranean diet is a dietary pattern that takes a variety of plant-based foods as the core, which is based on a high intake of fresh fruits, vegetables, potatoes, whole grains, legumes, nuts and seeds, and emphasizes simple processing, using local seasonal ingredients to reduce the loss of antioxidants and trace elements. Low-fat or nonfat dairy products such as cheese. In terms of high-quality protein sources, fish (especially deep-sea fish rich in omega-3 fatty acids) and poultry should be eaten at least twice a week, red meat intake should be limited to 340-450 grams per month, lean red meat should be preferred, refined sugar and highly processed foods should be avoided, fresh fruits should be used instead of desserts, and red wine should be consumed in moderation during meals. In addition to the dietary structure, the Mediterranean diet advocates a moderately balanced lifestyle, including regular exercise, social meals, and a positive mental outlook. At the same time, nutritionists have found that the low rate of chronic diseases among residents of Italy, Spain, Greece, Morocco and other countries living on the Mediterranean coast of Europe is due to the adoption of the Mediterranean diet, which can be concluded to have a protective effect on COPD patients.

Fischer et al^[10]Based on the Mediterranean diet score, it was found that smokers who received the guidance of the Mediterranean diet had better lung function protection effect, which was conducive to reducing the risk of COPD to a certain extent, Martín-Luján et al^[11]Forced spirometry was used to assess lung function, along with 14-item questionnaires and medical tests (oxidative, inflammatory, and depletion biomarkers) to assess MD adherence, leading to the conclusion that increased adherence to the Mediterranean diet prevented deterioration of lung function in smokers.

The Mediterranean diet can exert protective effects through multiple pathways: polyphenols in olive oil and omega-3 fatty acids in fish can inhibit the release of inflammatory factors in the lungs (such as IL-6, TNF- α) and terminate the vicious cycle between COPD inflammation and oxidative stress; A variety of antioxidants (vitamin C, carotenoids) can neutralize free radicals, reduce oxidative damage in the respiratory tract, and slow down the decline of lung function; High dietary fiber can produce short-chain fatty acids by regulating intestinal flora, inhibit the inflammatory response of Th17 in the lungs, and improve the functional status of the "gut-lung axis". Moderate intake of high-quality protein and low glycemic index carbohydrates can manage body weight, reduce respiratory stress associated with obesity, and omega-3 fatty acids can inhibit the breakdown of skeletal muscle proteins and slow down muscle wasting in COPD patients. Clinical studies have shown:^[12]Although the positive effects of the Mediterranean diet on the health of European and American populations have been widely verified, and its anti-inflammatory properties and protective effects of the respiratory system have been supported by a number of clinical trials, they are affected by dietary structure and cultural differences. The localized research on this dietary pattern in the field of COPD prevention and treatment in China is still relatively insufficient. In the future, there is an urgent need to use multicenter randomized controlled trials to comprehensively evaluate the regulatory efficacy of olive oil and deep-sea fish in the core components of the Mediterranean diet on lung function indicators (such as FEV1/FVC) and inflammatory factor levels (such as IL-6, CRP) in elderly patients with COPD, and at the same time implement dietary improvement in combination with the theory of traditional Chinese medicine dietary therapy, and then establish a nutritional intervention system that fits the metabolic characteristics of the Chinese population, so as to provide evidence-based medical examples for improving the prevention and treatment strategies of chronic respiratory diseases.

(2) DASH diet

The DASH diet is a dietary pattern centered on whole grains, dark vegetables and low-fat dairy products, emphasizing the need to consume sufficient vegetables every day, with the help of a combination of nutrients high in potassium, magnesium and calcium (such as potassium to help sodium excretion, magnesium to regulate the tone level of blood vessels, calcium to maintain the normal functioning of neuromuscular) to reduce blood pressure, to give priority to deep-sea fish rich in omega-3 fatty acids (such as salmon) and skinless poultry as a source of protein, and to strictly limit the consumption of red meat and processed foods. Reduces damage to the endothelium of blood vessels caused by saturated fats and invisible salts such as nitrites, while preventing added sugars, thereby improving insulin sensitivity. To improve adherence, it is proposed to replace salt with natural flavors (e.g., turmeric, black pepper) and acidic flavorings (e.g., lemon juice, apple cider vinegar) to reduce fluid retention from sodium intake and strengthen antioxidant defenses with polyphenols. The DASH diet can cause a decrease in systolic blood pressure, improve vascular endothelial function and insulin sensitivity, and has the potential to benefit COPD patients with metabolic syndrome.

A prospective cohort study of women found^[13], high fiber intake can reduce the risk of COPD in people with a history of smoking and current long-term smokers, and this dietary pattern contains a lot of dietary fiber, which has the effect of protecting lung function, and then reducing the incidence of COPD, Ardestani et al^[14] A case-control study using a validated food frequency questionnaire to assess usual dietary intake and spirometry testing to assess lung function showed that the DASH diet was positively associated with COPD incidence, with a gradual reduction in cough symptoms if the DASH diet was adhered to for a long time.

Diet alleviates the pathological evolution of COPD through multiple mechanisms: eating a diet high in potassium and magnesium can regulate electrolyte homeostasis, reduce pulmonary edema, and improve the contractility of respiratory muscles; The omega-3 fatty acids contained in deep-sea fish can inhibit the NF- κ B inflammatory pathway in the lungs, thereby reducing the levels of pro-inflammatory factors such as IL-6 and CRP, and slowing down the pace of airway remodeling. Antioxidants such as vitamin C and flavonoids can neutralize free radicals and reduce alveolar epithelial damage caused by oxidative stress; Whole grains with low glycemic index and dietary fiber can regulate blood sugar fluctuations and reduce the respiratory load caused by obesity, especially for elderly COPD patients with metabolic syndrome, which can be used to understand the potential application value of DASH diet in the management of respiratory diseases.

(3) Low-carb diet

A low-carbohydrate diet is a dietary pattern characterized by limiting carbohydrate intake (usually < 30% of total energy), moderate protein (20%-30%), and a high proportion of healthy fats (e.g., olive oil, nuts, deep-sea fish) to improve metabolic disorders by reducing blood sugar fluctuations and insulin resistance, and to produce ketones for a stable supply of energy through fat metabolism.

Zhu Yazhen and others^[15] Meta-analyses have shown that low-carbohydrate diets are beneficial in improving ventilation in patients with COPD in acute exacerbations, and that hypercapnia can be used to control or prevent disease.

The low-carbohydrate diet has a potential positive effect on COPD, and this diet has a synergistic effect with the Mediterranean diet in terms of anti-inflammatory mechanism: both emphasize deep-sea fish rich in omega-3 fatty acids and monounsaturated fatty acids, and its inhibition of the NF- κ B pathway can reduce the levels of inflammatory factors such as IL-8 and TNF- α in alveolar lavage fluid of COPD patients; Polyphenols in nuts and seeds can increase the activity of antioxidant enzymes (such as SOD and GPX) by activating the Nrf2 pathway, and reduce lung tissue damage caused by oxidative stress. By reducing the consumption of refined carbohydrates, the low-carb mode can reduce the inhibition of postprandial hyperglycemia on mitochondrial function in respiratory muscles, and may also improve the symptoms of respiratory labor.

3 Advantages and disadvantages of eating patterns

Anti-inflammatory, antioxidant and metabolic regulation are the common mechanisms of Mediterranean diet, DASH diet and low-carbohydrate diet to improve the prognosis of COPD.

Inhibition of inflammatory pathways: The three dietary patterns down-regulated pro-inflammatory signaling pathways such as NF- κ B and STAT3 through omega-3 fatty acids (deep-sea fish) and polyphenols (olive oil and nuts), and reduced the release of inflammatory factors such as IL-6 and TNF- α .

Oxidative stress antagonism: Antioxidant networks such as vitamin C, carotenoids and selenium work together to neutralize free radicals to protect alveolar epithelial cells from oxidative damage.

Metabolic homeostasis regulation: Low glycemic index carbohydrates and dietary fiber improve blood glucose fluctuations, and healthy fats (e.g., monounsaturated fatty acids) improve insulin sensitivity, thereby reducing metabolic syndrome-related respiratory load.

However, there is a potential contradiction between nutritional balance and metabolic risk between different dietary patterns:

(1) Trade-offs of carbohydrate restriction: Although a low-carb diet can reduce oxidative stress by reducing glucose toxicity, maintaining a very low carbohydrate intake (<20%) for a long time may accelerate the breakdown of skeletal muscle and increase the risk of cachexia in COPD patients;

(2) Two-way effects of protein intake: high-protein diets, such as the DASH diet, are helpful for muscle synthesis but may increase the risk of azotemia in older patients with COPD and renal function problems;

(3) Preferential choice of fat sources: The Mediterranean diet highlights monounsaturated fatty acids, while the low-carb diet relies on polyfats, and the long-term effects of different fatty acid ratios on lung function need to be further verified.

Most of the current studies only carry out the analysis of the effect of a single dietary pattern, and do not carry out a systematic exploration of the interaction between different dietary structures, which can provide theoretical support for personalized nutritional intervention in COPD and lay a solid evidence-based foundation for clinical dietary recommendations.

Based on the characteristics of the different course of COPD and comorbidities, we put forward a phased dietary management recommendation, and pay attention to the principle of "individualized" in specific operations. For patients with relatively stable disease, the Mediterranean diet is recommended first, such as cooking with 30ml of olive oil per day, intake of deep-sea fish twice a week, and choosing coarse grains such as brown rice and oats as staple foods. Blood should be drawn every 3 months to test for inflammatory markers, such as C-reactive protein (CRP) and interleukin-6 (IL-6), which are particularly important - if the CRP does not drop by more than 20% after 12 weeks, the proportion of antioxidants should be adjusted in the diet. In older patients with high blood pressure, a modified DASH diet may be more suitable. Such patients should pay special attention to "salt control but not potassium control": while ensuring daily potassium intake, the amount of salt must be stuck within 5g. However, it should be noted that when using natural spices such as tangerine peel and hawthorn instead of table salt, it is necessary to check your electrolyte status every half month, especially for patients with reduced kidney function. Dietary management during an acute exacerbation should be more cautious. At this time, you can adopt a low-carb diet for about 4 weeks, focusing on high-quality fat and whey protein powder. In particular, it is necessary to use BCAA supplements (it is recommended to choose products containing leucine). Of course, during this period, blood gas indicators should be observed, and if the partial pressure of carbon dioxide (PaCO_2) is observed above 50mmHg, it means that the diet is not suitable and the intervention needs to be terminated immediately. In practice, it is recommended to adapt measures to local conditions, such as in the southern region, camellia oil can be used instead of olive oil; If patients in the north are not used to eating cheese, they can also switch to tofu. It is recommended that community hospitals keep a simple nutrition assessment form (e.g., MNA-SF scale) and preferably develop some localized recipes. The most important thing is to open up the line of family-community-hospital, for example, let family members learn to read food labels, community nurses regularly visit to teach the knowledge of nutritious meals, and tertiary hospitals are responsible for formulating personalized plans - so that diet management can be truly implemented.

4 Conclusion

This study systematically explained the mechanism and clinical significance of different dietary patterns in elderly patients with COPD, and verified the key role of overall dietary structure optimization in improving lung function, reducing inflammation and improving quality of life. The results of this study not only provide a hierarchical and precise nutritional intervention strategy for clinical practice, but also lay a scientific foundation for the transformation of COPD nutrition research from a single nutritional element to a multi-dimensional dietary pattern, which is of great significance for improving the quality of chronic disease management in the elderly.

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