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Relationship between diet and chronic obstructive pulmonary disease

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Abstract. Chronic Obstructive Pulmonary Disease (COPD) is one of the primary global epidemics and a growing healthcare problem. In addition to the influence of common risk elements such as cigarette smoking and contamination of the environment on COPD, diet is increasingly recognized as one of the influencing factors of COPD, and academics have identified that diet is an indispensable portion of the COPD process from its prevention to its treatment. This review provides an overview of the relationships between different types of dietary patterns, specific nutrients, specific foods, and COPD across the three dietary classifications. It also analyzes the mechanisms of influence and provides evidence and conclusions from previous relevant studies. The review finds that the healthy dietary pattern, the Mediterranean dietary pattern, and the partially vegan dietary pattern can reduce the risk of COPD; meanwhile, the foods (e.g., fruits, vegetables, and fish) and the nutrients (e.g., dietary fibers, antioxidants such as vitamin C and vitamin D) these dietary patterns contain can also reduce the risk of COPD; while the Western dietary pattern and the foods they contain (e.g., red or processed meats, sweet food) increase the exposure of COPD; however, there is no substantial evidence for the effect of the mineral Magnesium on COPD.

Keywords: Diet, Chronic obstructive pulmonary disease, Dietary pattern, Antioxidant, Nutrient.

1. Introduction

Chronic obstructive pulmonary disease (COPD) is a slow-progressing chronic breathing disease labeled by an obstructive ventilatory pattern that is infrequently reversible and can lead to chronic breathing exhaustion [1]. COPD is currently the third most common reason for death across the globe, and academics have been known to discuss the effects of smoking or environmental pollution on COPD, both of which have been shown to be the cause of COPD morbidity. In the last few years, the influence of diet on COPD victims has become a hot topic of research, and some scholars believe that diet influences the risk and progression of COPD. Now, diet has been used as an intervention in the treatment process of clinical COPD patients. Therefore, this review aims to explore the link between diet and COPD.

This review divides the diets into three separate sections to explore their relationship with COPD. The first section is about dietary patterns, and this review lists four of them which are the healthy dietary pattern, the Western dietary pattern, the Mediterranean dietary pattern, and the vegan dietary pattern. The second part is about specific nutrients, which include antioxidant nutrients (Vitamin C and Vitamin D), dietary fiber, and the mineral Magnesium. The third section is about specific foods, which include

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the common foods of fruits, vegetables, and fish, as well as red or processed meats and sweet foods in the Western dietary pattern.

This paper can help obtain a better understanding of the impact that dietary factors have on COPD, which will allow clinical specialists to provide an evidentiary basis for improving patients' lung function and provide direction and guidance for future research on preventing the occurrence and exacerbation of COPD.

2. Relationship between different dietary patterns and COPD

2.1. Healthy dietary pattern

A healthy dietary pattern is typified by the consumption of more vegetables, fruits, fish, and whole-grain products [2]. It would also be called a "cautious" dietary pattern. Studies have already demonstrated that a healthy dietary pattern can reduce exposure to COPD [2-4]. This suggests that a healthy dietary pattern contributes positively to the prevention of COPD. For those who do not have COPD, adopting a healthy diet can be effective in preventing COPD; and for those who already have COPD, it is important to adhere to a healthy diet during disease treatment and intervention.

2.2. Western dietary pattern

The Western dietary pattern is recognized as heavy ingestion of a variety of red or processed meats, refined grains, sweets, desserts, and French fries [2]. It would also be called an unhealthy dietary pattern because it contains a lot of sweet food as well as processed, refined, and fried food. It has been proven that the Western dietary pattern may raise the prevalence and danger of COPD [2-4]. This indicates that people with or without COPD should avoid high-frequency consumption of the Western dietary pattern, and people who are in a Western dietary pattern can try eating healthy food multiple times a week.

2.3. Mediterranean dietary pattern

The concept of the Mediterranean dietary pattern was first proposed by Ancel Keys in conjunction with Seven Nations Cardiovascular Disease [5]. The conventional Mediterranean dietary pattern is described as being characterized by a combination of high amounts of vegetables, legumes, fruits, nuts, unrefined grains, olive oil, and fish, with low to moderate consumption of dairy products and low levels of intake of saturated fats, meat, and poultry [6]. Alexandra Fischer has found that adherence to the Mediterranean dietary pattern is inversely correlated with the occurrence of COPD [7]. Being consistent with the relationship between the healthy dietary pattern and COPD, the Mediterranean diet also reduces the risk of COPD, which is explained by the large overlapping portion of the Mediterranean dietary pattern and the healthy dietary pattern.

2.4. Vegan dietary pattern

The vegan diet has been a popular way of eating in recent years, and it is believed that eating a vegan diet can help with health, fat loss, and body contouring. A vegan diet, also called a "plant-based diet," is a broad pattern of eating that includes more plant products and fewer animal products [8]. Varraso, who categorized vegan diets into healthy plant-based diets (eating a variety of healthy plant foods and meats) and unhealthy plant-based diets (eating a lot of added sugar and refined carbohydrates), has found that adherence to a healthy and plant-based diet is significantly less associated with the development risk of COPD, whereas adherence to an unhealthy vegetable-based diet is related to an enhanced risk of developing COPD [9].

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3. Relationship between specific nutrients and COPD

3.1. Antioxidants

Antioxidants are used to protect against oxidizing agents, and their principal mechanism of operation is to protect the lungs from various oxidizing agents or reactive oxygen species that can lead to the consequences of confusion [10].

3.1.1. Vitamin C. Oxidative stress is the result of an imbalance of oxidants/antioxidants which has a critical role to play in the pathogenesis of COPD. It has been found that increasing oxidative stress leads to dysregulation of antiproteases in pulmonary tissues, which are central to the pathogenesis of emphysema in COPD. In addition, molecular oxidative stress contributes to pulmonary fibrosis [11]. Vitamin C is a widely publicized antioxidant. Its mechanism of action is to maintain transient oxidants (e.g., oxygen and nitric oxide) and long-acting oxidants (e.g., semiquinone radicals) in their respective states of reduction to exert its antioxidant function [10]. The results of a meta-analysis of Lei's study have shown that Vitamin C supplementation promotes improved lung function in patients with COPD [11]. Vitamin C supplementation improves lung function, which may be due to the fact that excessive oxidative load in COPD is a frequent phenomenon induced by both hypoxia and infection, which plays a crucial role in lung tissue damage and remodeling processes [11]. Due to its antioxidant properties, Vitamin C is effective in reducing oxidative stress, which would slow down the reshaping of the lung tissue and further slow down the decline of lung capacity [12]. Vitamin C intake is clinically important in reducing oxidative damage to the lungs as well as promoting lung capacity and antioxidant levels in serum in COPD patients.

3.1.2. Vitamin D. Vitamin D is a pleiotropic hormone with a ubiquitous distribution of its receptors (VDRs) [13]. Being an immunomodulator, Vitamin D is capable of not only enhancing the inborn immunity response at the time of infection but also modulating the adaptive immune response [14]. The results of Zhu's meta-analysis study have shown that Vitamin D deficiency puts subjects at higher risk for COPD [15]. The main reason for this is that most Vitamin D comes from sun-exposed skin [16], and COPD patients have less sun exposure due to reduced outdoor activity, which leads to reduced skin Vitamin D synthesis, increased Vitamin D catabolism, and decreased Vitamin D storage capacity as a result of glucocorticoids [17]. Vitamin D deficits are known to be associated with an extended risk of developing COPD, with substantial implications for clinical COPD.

3.2. Dietary fiber

Consumption of anti-inflammatory dietary fiber prevents COPD by protecting the lungs from inflammatory attacks [18]. Szmidt's forward-looking cohort study of women discovered that a high intake of dietary fiber had an inverse correlation with the risk of COPD [18], while Kaluza's prospective study of a population of men high in fiber intake found that intake of total and grain fiber was negatively affected by the risk of COPD [19]. An underlying mechanism by which dietary fiber decreases the risk of COPD could be related to the specific anti-inflammatory properties of dietary fiber [19]. Past studies have shown that dietary fiber ingestion is connected with a reduction in the levels of the systemic marker of inflammation, C-reactive protein [20]. In addition, dietary fiber modulates inflammation through a slowing of glucose absorption, reducing oxidized lipids, and affecting the production of anti-inflammatory cytokine by intestinal flora [21].

3.3. Minerals (Magnesium)

Magnesium performs a crucial function in a variety of physiological processes within the cell [22]. Magnesium has a bronchodilation effect mainly on the airways of patients with COPD [23]. Previous studies have shown that the total magnesium pool in the body is often reduced in patients with COPD, especially in older adults [24]. Earlier studies based on populations reported a robust relationship between magnesium intake and bronchial obstruction, respiratory hyperresponsiveness of the airways,

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wheezing, and inflammation in patients with COPD [25]. To date, there is no substantial evidence as to whether magnesium affects lung performance in individuals with COPD. The results of Zanforlini's study suggest that magnesium supplements taken orally in patients with COPD may have a possible anti-inflammatory effect but do not appear to have a substantial impact on lung function, fitness performance, or quality of life in patients with COPD [24]. Although the anti-inflammatory effects of magnesium are protective of lung function and COPD, further prospective research is necessary to establish whether magnesium can truly influence the progression of COPD.

4. Relationship between specific foods and COPD

4.1. Fruits and vegetables

It is well known that fruits and vegetables are considered symbols of health and are included in the dietary composition of both the healthy dietary pattern and the Mediterranean dietary pattern. Zheng's research concluded that increased consumption of fruits and vegetables may help prevent COPD [2], and this is the explanation why healthy eating patterns and Mediterranean dietary patterns can lower the risk of COPD. Fruits and vegetables are high in antioxidants (especially Vitamin C), and antioxidants protect the highly oxidized environment of the lungs, which can have beneficial effects in COPD [7]. Szmidt found that dietary fiber may exert a useful effect on the reduction of oxidative stress in the pulmonary region through the antioxidant ability of fruits and vegetables, which in turn reduces the risk of developing COPD [18]. Therefore, consuming fruits and vegetables is an important and decisive factor in lung function and the risk of COPD.

4.2. Red or processed meats

Red or processed meats are one of the common staples of the Western dietary pattern, and eating processed meats with high frequency is harmful to human health. The results of several studies suggested that intake of red or processed meats was found to be linked to an enhanced risk of developing COPD [2,3], and that the mechanism of action is the high levels of nitrates or nitrites and nitrosamine compounds in processed meats, including cured meats. The reactive nitrogen produced by nitrites amplifies the inflammatory process in the respiratory tract and pulmonary parenchyma, leading to DNA lesions, inhibited mitochondrial breathing, and nitrosative stress, resulting in progressive deterioration of lung function [26].

4.3. Sweet food

Sweet food is certainly unhealthy, and the Western dietary pattern includes sweet foods such as sweets, desserts, and some refined grains. Zheng's study proved that desserts and refined grains are hidden risk variables for COPD [2]. Sweets have a high-glycemic index, and previous studies have shown that hyperglycemia is connected to compromised lung function, the primary indicator for the assessment of COPD [27].

4.4. Fish

Fish, like fruits and vegetables, is a healthy food and is also included in both the healthy dietary pattern and the Mediterranean dietary pattern. Studies have shown that fish intake decreases the risk of developing COPD and slows the development of COPD [2,7]. Fish is among the major sources of omega-3 polyunsaturated fatty acids [3]. Since omega-3 fatty acids exhibit anti-inflammatory characteristics and inflammation plays an important role in COPD [7], fish may diminish the risk of developing COPD.

5. Conclusion

This review summarizes the findings by searching current academic published articles on the relationship between diet and COPD: (1) Regarding the relationship between dietary patterns and COPD, the healthy dietary pattern, the Mediterranean dietary pattern, and the partially vegan dietary pattern

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reduce the risk of COPD, while the Western dietary pattern increases the risk of COPD. (2) Regarding the relationship between specific nutrients and COPD, antioxidants (Vitamin C and Vitamin D) and dietary fiber reduce the risk of COPD and increase lung function, while the link between the mineral Magnesium and COPD has not yet been substantially demonstrated. (3) Regarding the relationship between specific foods and COPD, fruits, vegetables, and fish reduce the risk and progression of COPD and are considered healthy foods, while red or processed meat and sweet foods increase the risk of COPD. There is a strong link between diet and COPD, and in the future, there could be studies showing the link between dietary patterns and COPD in different geographic areas based on regional divisions around the world. Moreover, the link between minerals and COPD can also be investigated. Finally, the biological mechanisms between diet and COPD are worth exploring as well, which could provide a clinical rationale for dietary intervention in COPD.

References

[1] Raherison, C. and Girodet, P.O. (2009). Epidemiology of COPD. Eur Respir Rev, 18(114), 213-21.
[2] Zheng, P.F., et al. (2016). Dietary Patterns and Chronic Obstructive Pulmonary Disease: A Meta-analysis. Copd, 13(4), 515-22.
[3] Varraso, R., et al. (2007). Prospective study of dietary patterns and chronic obstructive pulmonary disease among US men. Thorax, 62(9), 786-91.
[4] Parvizian, M.K., et al. (2020). Relationship between dietary patterns and COPD: a systematic review and meta-analysis. ERJ Open Res, 6(2).
[5] Menotti, A. and Puddu, P.E. (2015). How the Seven Countries Study contributed to the definition and development of the Mediterranean diet concept: a 50-year journey. Nutr Metab Cardiovasc Dis, 25(3), 245-52.
[6] Trichopoulou, A., et al. (1995). Diet and overall survival in elderly people. Bmj, 311(7018), 1457-60.
[7] Fischer, A., et al. (2019). Adherence to a Mediterranean-like Diet as a Protective Factor Against COPD: A Nested Case-Control Study. Copd, 16(3-4), 272-277.
[8] Hemler, E.C. and Hu, F.B. (2019). Plant-Based Diets for Personal, Population, and Planetary Health. Adv Nutr, 10(Suppl_4), S275-s283.
[9] Varraso, R., et al. (2023). Healthful and Unhealthful Plant-Based Diets and Chronic Obstructive Pulmonary Disease in U.S. Adults: Prospective Study. Nutrients, 15(3).
[10] Rahman, I., Biswas, S.K. and Kode, A. (2006). Oxidant and antioxidant balance in the airways and airway diseases. Eur J Pharmacol, 533(1-3), 222-39.
[11] Lei, T., et al. (2022). Efficacy of Vitamin C Supplementation on Chronic Obstructive Pulmonary Disease (COPD): A Systematic Review and Meta-Analysis. Int J Chron Obstruct Pulmon Dis, 17, 2201-2216.
[12] Barnes, P.J. (2022). Oxidative Stress in Chronic Obstructive Pulmonary Disease. Antioxidants (Basel), 11(5).
[13] Hollis, B.W. and Wagner, C.L. (2013). Clinical review: The role of the parent compound vitamin D with respect to metabolism and function: Why clinical dose intervals can affect clinical outcomes. J Clin Endocrinol Metab, 98(12), 4619-28.
[14] Prietl, B., et al. (2013). Vitamin D and immune function. Nutrients, 5(7), 2502-21.
[15] Zhu, M., et al. (2016). The association between vitamin D and COPD risk, severity, and exacerbation: an updated systematic review and meta-analysis. Int J Chron Obstruct Pulmon Dis, 11, 2597-2607.
[16] Finklea, J.D., Grossmann, R.E. and Tangpricha, V. (2011). Vitamin D and chronic lung disease: a review of molecular mechanisms and clinical studies. Adv Nutr, 2(3), 244-53.
[17] Janssens, W., et al. (2011). Vitamin D deficiency and chronic obstructive pulmonary disease: a vicious circle. Vitam Horm, 86, 379-99.

[18] Szmidt, M.K., et al. (2020). Long-term dietary fiber intake and risk of chronic obstructive pulmonary disease: a prospective cohort study of women. Eur J Nutr, 59(5), 1869-1879.
[19] Kaluza, J., et al. (2018). Dietary Fiber Intake and Risk of Chronic Obstructive Pulmonary Disease: A Prospective Cohort Study of Men. Epidemiology, 29(2), 254-260.
[20] Ma, Y., et al. (2006). Association between dietary fiber and serum C-reactive protein. Am J Clin Nutr, 83(4), 760-6.
[21] Basu, A., Devaraj, S. and Jialal, I. (2006). Dietary factors that promote or retard inflammation. Arterioscler Thromb Vasc Biol, 26(5), 995-1001.
[22] Fawcett, W.J., Haxby, E.J. and Male, D.A. (1999). Magnesium: physiology and pharmacology. Br J Anaesth, 83(2), 302-20.
[23] Makwana, S., Patel, A. and Sonagara, M. (2022). Correlation Between Serum Magnesium Level and Acute Exacerbation in Patients With Chronic Obstructive Pulmonary Disease (COPD). Cureus, 14(6), e26229.
[24] Zanforlini, B.M., et al. (2022). Clinical trial on the effects of oral magnesium supplementation in stable-phase COPD patients. Aging Clin Exp Res, 34(1), 167-174.
[25] Britton, J., et al. (1994). Dietary magnesium, lung function, wheezing, and airway hyperreactivity in a random adult population sample. Lancet, 344(8919), 357-62.
[26] Ricciardolo, F.L., et al. (2006). Reactive nitrogen species in the respiratory tract. Eur J Pharmacol, 533(1-3), 240-52.
[27] Walter, R.E., et al. (2003). Association between glycemic state and lung function: the Framingham Heart Study. Am J Respir Crit Care Med, 167(6), 911-6.