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The Impact of Different Nutrients on Obesity and the Progress of the Application of Diet in Its Management

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Abstract: With the improvement of living standards and lifestyle changes, obesity has become a major global public health concern, closely linked to various chronic diseases such as cardiovascular diseases, diabetes, and hypertension. Nutrient intake plays a crucial role in obesity development and management. This review explores the effects of macronutrients and micronutrients on obesity and examines the progress in dietary pattern applications for weight control. Protein intake is essential for satiety, energy metabolism, and muscle maintenance, while fat type and proportion significantly influence obesity risk. Carbohydrates and micronutrients, such as vitamin D, also contribute to obesity-related metabolic processes. Additionally, dietary patterns, including the Mediterranean diet and low-carbohydrate diet, have shown benefits in weight control. While existing studies provide valuable insights, this review highlights the need for further research on personalized obesity management, considering factors such as age, gender, genetics, and environmental interactions. Future studies should focus on individualized dietary strategies to enhance obesity prevention and treatment. Understanding the complex relationship between diet and obesity can help develop more effective interventions, providing scientific guidance for weight management and overall health improvement.

Keywords: Nutrition, obesity, Mediterranean diet.

1. Introduction

With the improvement of living standards and changes in lifestyle, obesity has become a growing public health problem worldwide. Obesity not only affects a person's appearance and mental health, but also is closely related to a variety of chronic diseases such as cardiovascular diseases, diabetes, hypertension, etc. Studies show that dietary nutrient intake plays a key role in the development of obesity.

In the study of the relationship between nutrients and obesity, a large number of literatures have been discussed. As an important component of the human body, the intake and mass of protein have an important impact on energy metabolism and weight management. Some studies have found that increasing protein intake can improve satiety and reduce appetite, which in turn helps to control weight. The type and intake of fat are also closely related to obesity, and excessive intake of saturated fatty acids is considered one of the important factors leading to obesity. The digestion and absorption rate of carbohydrates and the glycemic index also affect the storage and consumption of energy. In terms of micronutrients, vitamin D has been found to be associated with obesity, and vitamin D deficiency may affect fat metabolism and insulin sensitivity.

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A lot of progress has also been made in the study of applying diet patterns to obesity management. For example, the Mediterranean diet pattern is rich in healthy fat, protein and dietary fiber, which has been proven to be beneficial to control weight and prevent obesity-related diseases. A low-carbohydrate diet (LCD) has also been found to be effective in reducing weight in the short term.

This article will mainly discuss the impact of different nutrients (including a large number of nutrients and micronutrients) on obesity, and review the progress of the application of diet patterns in obesity management. By analyzing relevant research, it aims to provide scientific dietary suggestions for the prevention and management of obesity, and help people better control their weight and improve their health.

2. Nutrients and obesity

2.1. Protein

2.1.1. The relationship between protein intake and satiety

Protein intake can quickly improve satiety. Judging from the order of gastrointestinal digestion, the rate of protein excretion in the stomach is relatively slow. When protein-rich food enters the stomach, it stimulates the stomach wall and transmits signals to the brain center through nerve conduction, filling people. For example, after an adult woman eats 300g of beef, she will feel full for a longer time than eating refined carbon water (such as bread and rice) with the same calories, thus reducing the intake of other types of food.

From the perspective of hormone regulation, amino acids produced in the process of protein digestion, especially branched-chain amino acids such as leucine, can stimulate the gastrointestinal tract to secrete a variety of hormones related to satiety, such as gallbladder contraction (CCK) and glucagon-like peptide-1 (GLP-1). CCK can not only promote gallbladder contraction and assist fat digestion, but also act on the appetite regulation area of the brain and inhibit appetite; [1].

2.1.2. The influence of proteins from different sources on energy metabolism

Proteins from different sources have different effects on energy metabolism because of their different amino acid composition, digestibility and other characteristics. Proteins derived from animals, such as eggs, milk, fish and beef, have an amino acid composition close to human needs. They are high-quality complete proteins with high digestion and absorption rates. Take eggs as an example, the protein in eggs contains essential amino acids needed by the human body, and the amino acid composition is close to the composition pattern of the human body, which is considered the most ideal high-quality protein. In terms of energy metabolism, after ingesting animal protein, the body's digestion and absorption are relatively efficient, which can provide the body with a stable supply of amino acids, support muscle synthesis, enzyme synthesis and other physiological processes, maintain a high basal metabolic level, and promote energy consumption.

Plant-based proteins, such as soybean protein, grain protein, etc., except for soybean protein, the amino acid composition of most plant proteins is not complete enough, there are limited amino acids, and the digestion and absorption rate is relatively low. However, soybean protein is rich in a variety of essential amino acids, has high nutritional value, and contains biologically active ingredients such as isoflavones, which have the effects of lowering blood lipids and anti-oxidation. Studies show that in the process of energy metabolism, soy protein may affect fat synthesis and decomposition by regulating the activity of enzymes related to fat metabolism, thus having a beneficial effect on energy metabolism. At the same time, foods derived from plant protein are usually rich in dietary fiber, which ferments in the intestine to produce short-chain fatty acids, affecting the composition of intestinal flora and indirectly regulating energy metabolism. Although grain protein has lysine and other

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limiting amino acids, when eaten with other lysine-rich foods, it can improve the utilization rate of protein and play a certain supporting role in energy metabolism [2].

2.1.3. The role of protein in maintaining muscle mass and basal metabolic rate

Protein is the main component of muscle tissue and plays a key role in maintaining muscle mass. Muscle growth and repair depend on continuous protein supply. After exercise, especially resistance training, muscle fibers will be damaged to a certain extent. At this time, sufficient protein intake can provide raw materials for muscle repair and growth, and promote muscle protein synthesis. By stimulating the activation and proliferation of muscle satellite cells, the diameter and number of muscle fibers are increased, thus maintaining and increasing muscle mass.

The basal metabolic rate is the lowest energy consumed by the human body to maintain life activities in a quiet state. Active muscle tissue metabolism is an important part of basal metabolism. Maintaining sufficient muscle mass helps to maintain a high basal metabolic rate. Because muscle cells are rich in mitochondria, they are an important place for energy metabolism. The increase in muscle mass means that more mitochondria are involved in the energy metabolism process, thus improving the basal metabolic rate and causing the body to consume more energy at rest. If protein intake is insufficient, muscle protein decomposition accelerates, muscle mass decreases, and the basal metabolic rate will also decrease, energy consumption will be reduced, which will increase the risk of obesity. Therefore, ensuring adequate protein intake is crucial to maintaining muscle mass and basal metabolic rate and preventing obesity [3].

2.2. Fat

2.2.1. The relationship between saturated fatty acids, unsaturated fatty acids and obesity

Saturated fatty acids are mainly found in animal oils and fats (such as butter and lard) and some tropical vegetable oils (such as coconut oil and palm oil). A large number of studies show that excessive intake of saturated fatty acids is closely related to the increased risk of obesity. Saturated fatty acids can affect body weight through many mechanisms. First, saturated fatty acids in the process of metabolism in the body will up-regulate the expression of liver fatty acid binding protein FABP1 and fatty acid transporter protein FATP2, promoting the intake and storage of fatty acids in the liver, resulting in a large accumulation of triglycerides in the liver and adipose tissue. Second, saturated fatty acids may also interfere with insulin signaling pathways, reduce insulin sensitivity, and reduce the body's ability to regulate blood sugar. Excessive blood sugar will be converted into fat storage, causing weight gain.

Unsaturated fatty acids are divided into monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFA). MUFAs are commonly found in olive oil, tea seed oil, etc., and PUFAs are mainly found in deep-sea fish oil, flaxseed oil, etc. MUFAs help reduce the level of low-density lipoprotein cholesterol (LDL-C) in the blood, while not affecting high-density lipoprotein cholesterol (HDL-C), which is conducive to maintaining cardiovascular health and reducing fat accumulation to a certain extent. Omega-3 fatty acids in PUFAs, such as docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), have the effect of regulating lipid metabolism, inhibiting the proliferation and differentiation of fat cells, reducing the expression of genes related to fat production, and thus reducing the risk of obesity [4].

2.2.2. The effect of trans fatty acids on weight gain

Trans fatty acids are mainly derived from partially hydrogenated vegetable oils, which are commonly found in fried foods (such as fried chicken and French fries), baked goods (such as cakes and biscuits)

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and margarine. Trans fatty acids have a significant effect on weight gain. Studies have found that trans fatty acids can change the distribution of body fat, making it easier for fat to accumulate in the abdomen, forming central obesity. This is because trans fatty acids will interfere with the normal fat metabolism process, inhibit the β-oxidation of fatty acids, block the catabolism of fat in the body, and also promote the proliferation and hypertrophy of fat cells. In addition, trans fatty acids may also affect hormone levels and reduce the secretion of leptin, which is a hormone that can inhibit appetite and regulate energy metabolism. A decrease in leptin levels will lead to increased appetite, which will promote weight gain [5].

2.2.3. The effect of the amount and proportion of fat intake on obesity

Fat intake is one of the key factors affecting obesity. When the total amount of fat ingested exceeds the body's energy consumption, excess fat will be stored in the body, resulting in weight gain. The World Health Organization (WHO) recommends that the fat energy supply ratio of adults should be controlled at 20%-30%. If it exceeds this range for a long time, the risk of obesity will increase significantly. For example, a long-term follow-up study of people with different fat intakes found that the incidence of obesity in people with a fat-energy ratio of more than 35% was significantly higher than that of people with a fat-energy ratio within a reasonable range.

The proportion of fat intake is equally important. A reasonable ratio of saturated fatty acids, MUFAs and PUFAs helps to maintain a healthy weight. Generally recommended saturated fatty acids: MUFAs: the ratio of PUFAs is 1:1.5:1. If the proportion is unbalanced, such as excessive intake of saturated fatty acids and insufficient intake of unsaturated fatty acids, it will break the balance of fat metabolism in the body and increase the risk of obesity and cardiovascular disease [6].

2.3. Carbohydrate

2.3.1. The difference between simple carbohydrates and complex carbohydrates and their impact on blood sugar

Simple carbohydrates are composed of one or two sugar molecules, also known as "simple sugars", which are commonly found in refined grains, added sugar, candies, baked goods and sugary drinks. Its rapid digestion and absorption will cause blood sugar to rise rapidly and then drop rapidly, resulting in large fluctuations in blood sugar. For example, after eating white bread or drinking sugary drinks, blood sugar will rise significantly in a short time. Complex carbohydrates are composed of multiple sugar molecules, including whole grains, beans, vegetables, etc. They need to be digested for a longer time and can slowly release glucose, so that blood sugar rises relatively slowly and maintain the stability of blood sugar. For example, eating brown rice and whole wheat bread, the increase in blood sugar is relatively small and stable [7].

2.3.2. The relationship between blood glucose generation index and obesity

Blood glucose generation index (GI) measures the rate and ability of food to raise blood sugar. High-GI foods are mostly simple carbohydrates. After entering the human body, they digest and absorb quickly, resulting in a rapid increase in blood sugar, stimulating a large amount of insulin secretion, and converting excess blood sugar into fat storage. Long-term large intake is easy to cause obesity. Low-GI foods are mostly complex carbohydrates, slow digestion and absorption, and small fluctuations in blood sugar, which can reduce fat accumulation and be conducive to weight control [8].

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2.3.3. The relationship between carbohydrate intake and fat storage

When carbohydrate intake exceeds the body's energy requirements, the excess will be converted into fat storage. Especially in the case of low exercise and low energy consumption, this transformation is more obvious. For example, long-term excessive intake of staple food and lack of exercise are easy to gain weight. Reasonable control of carbohydrate intake and matching the body's energy consumption are conducive to maintaining a healthy weight and avoiding excessive fat storage [9].

2.4. Vitamin

2.4.1. The relationship and mechanism of action between vitamin D and obesity

The serum vitamin D level of obese people is often lower than that of normal people. On the one hand, obese people do less outdoor activities, the skin's exposure to ultraviolet radiation is shortened, and the endogenous vitamin D synthesis is significantly reduced. On the other hand, vitamin D deficiency in the blood circulation may lead to a decrease in the body's leptin level, coupled with the accumulation of vitamin D in fat cells of obese people to inhibit leptin secretion, thus affecting weight loss. Vitamin D can participate in regulating the synthesis and decomposition of fat cells. In the process of fat cell formation, it inhibits the differentiation of pre-fat cells into mature fat cells, and can also effectively promote the synthesis of "leptin". Leptin makes people feel full, inhibits eating behavior, and plays an important role in preventing obesity [10].

2.4.2. The potential role of other vitamins (such as vitamin C, vitamin E, etc.) in obesity

Vitamin C can synthesize carnitine, promote fat metabolism, help fat decomposition and burn, and help reduce fat accumulation. It can be obtained from spinach, broccoli, broccoli, tomatoes, kiwifruit and other foods. Vitamin E has antioxidant effects, which can protect cells from oxidative stress damage. It may be involved in regulating the function of adipocytes, but the link between it and obesity is still under further study [11].

3. Mediterranean Diet (MD)

3.1. Characteristics and main food composition of the MD

The MD is based on rich plant foods, including a large number of fruits, vegetables, whole grains, beans and nuts. Its healthy fat mainly comes from olive oil, which also contains an appropriate amount of fish, seafood, and a small amount of dairy products, meat and poultry. This diet mode emphasizes the naturalness and freshness of the ingredients, and the cooking method is also relatively simple. It is mostly steamed, cold, etc., and less fried and fried [12].

3.2. The effect of MD on weight management and obesity prevention

It has a significant effect on weight management. Rich dietary fiber increases satiety and reduces the intake of other high-calorie foods; MUFAs in olive oil and omega-3 fatty acids in fish help regulate lipid metabolism and reduce fat accumulation, thus effectively preventing obesity [13].

3.3. Health benefits and mechanisms of the MD

In addition to weight management, it can also reduce the risk of obesity-related complications such as cardiovascular diseases. Its mechanism involves anti-inflammatory, antioxidant and regulating the intestinal flora. The antioxidants in olive oil and a variety of nutrients in plant-based foods can reduce

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inflammation in the body and oxidative stress; while high-fiber foods can regulate intestinal flora, maintain intestinal health, and thus improve the overall metabolic function [14].

4. LCD

4.1. The principle and classification of LCD

The principle is to limit carbohydrate intake, so that the body can change from burning glucose energy supply to burning fat energy supply. It can be divided into a strict LCD, such as a very low-carbohydrate ketogenic diet, with extremely low carbohydrate intake, generally less than 10% of the total daily calories; and a moderate LCD, with carbohydrate intake usually accounts for 20%-40% of the total daily calories (depending on the actual situation There are fluctuations with different studies) [15].

4.2. Short-term and long-term effects of an LCD

In the short term, you can lose weight quickly, mainly due to water loss and fat decomposition. In the long run, some people can maintain their weight, but some studies show that long-term maintenance may cause weight rebound [16].

4.3. Potential risks and precautions for an LCD

Potential risks include unbalanced nutrition, limited intake of cereals, etc., may lack of dietary fiber, leading to intestinal dysfunction; it may also increase the burden on the kidneys, especially when the protein intake is high. It should be noted that food should be reasonably matched to ensure sufficient intake of vegetables, fruits, high-quality protein and healthy fat to meet the body's nutritional needs. At the same time, before adopting this diet, it is best to consult a doctor or nutritionist, especially for people with underlying diseases [17].

5. Conclusion

This article discusses in detail the impact of different nutrients on obesity and the application progress of multiple dietary patterns in obesity management. Protein is crucial to weight management in terms of improving satiety, affecting energy metabolism and maintaining muscle mass; the type, intake and proportion of fat are closely related to the risk of obesity. In addition, carbohydrates and micronutrients also play their own roles in the process of obesity, and different diet patterns also have their own advantages and disadvantages. These research results provide a scientific basis for the prevention and management of obesity, make people realize the importance of rationally matching nutrients and choosing diet patterns, to control weight and improve health, and also lay the foundation for subsequent obesity research. However, this article does not deeply analyze the differential reactions of different individuals (such as different ages, genders and genetic backgrounds) to nutrients and diet patterns, nor does it fully explore the impact of the interaction between environmental factors and diet on obesity. Future research can focus on personalized obesity management schemes and deeply explore the complex relationship between environment and diet, so as to prevent and control obesity more effectively.

References

[1] *Aldawsari, M., Almadani, F. A., Almuhammadi, N., Algabsani, S., Alamro, Y., & Aldhwayan, M. (2023). The efficacy of GLP-1 analogues on appetite parameters, gastric emptying, food preference and taste among adults with obesity: systematic review of randomized controlled trials. Diabetes, Metabolic Syndrome and Obesity, 575-595.*

DOI: 10.54254/2753-8818/110/2025.AU23155

[2] *Matthews, D. E. (2020). Review of lysine metabolism with a focus on humans. The Journal of nutrition, 150, 2548S-2555S.*

[3] *Simonson, M., Boirie, Y., & Guillet, C. (2020). Protein, amino acids and obesity treatment. Reviews in endocrine and metabolic disorders, 21(3), 341-353.*

[4] *Mariamenatu, A. H., & Abdu, E. M. (2021). Overconsumption of Omega-6 polyunsaturated fatty acids (PUFAs) versus deficiency of Omega-3 PUFAs in modern-day diets: the disturbing factor for their "balanced antagonistic metabolic functions" in the human body. Journal of lipids, 2021(1), 8848161.*

[5] *Alhabeeb, H., AlFaiz, A., Kutbi, E., AlShahrani, D., Alsuhail, A., AlRajhi, S., ... & AlJohani, N. (2021). Gut hormones in health and obesity: the upcoming role of short chain fatty acids. Nutrients, 13(2), 481.*

[6] *World Health Organization. (2023). Carbohydrate intake for adults and children: WHO guideline. World Health Organization.*

[7] *Hashimoto, M., Hossain, S., Matsuzaki, K., Shido, O., & Yoshino, K. (2022). The journey from white rice to ultra-high hydrostatic pressurized brown rice: an excellent endeavor for ideal nutrition from staple food. Critical reviews in food science and nutrition, 62(6), 1502-1520.*

[8] *Mapengo, C. R., & Emmambux, M. N. (2022). Processing Technologies for Developing low GI foods–a review. Starch-Stärke, 74(7-8), 2100243.*

[9] *Volek, J. S., Kackley, M. L., & Buga, A. (2024). Nutritional considerations during major weight loss therapy: focus on optimal protein and a low-carbohydrate dietary pattern. Current Nutrition Reports, 13(3), 422-443.*

[10] *Obradovic, M., Sudar-Milovanovic, E., Soskic, S., Essack, M., Arya, S., Stewart, A. J., ... & Isenovic, E. R. (2021). Leptin and obesity: role and clinical implication. Frontiers in endocrinology, 12, 585887.*

[11] *García-Sánchez, A., Miranda-Díaz, A. G., & Cardona-Muñoz, E. G. (2020). The role of oxidative stress in physiopathology and pharmacological treatment with pro-and antioxidant properties in chronic diseases. Oxidative medicine and cellular longevity, 2020(1), 2082145.*

[12] *Sharma, S. K., Barthwal, R., Saini, D., & Rawat, N. (2022). Chemistry of food fats, oils, and other lipids. In Advances in food chemistry: Food components, processing and preservation (pp. 209-254). Singapore: Springer Nature Singapore.*

[13] *Méndez, L., & Medina, I. (2021). Polyphenols and fish oils for improving metabolic health: A revision of the recent evidence for their combined nutraceutical effects. Molecules, 26(9), 2438.*

[14] *Ye, S., Shah, B. R., Li, J., Liang, H., Zhan, F., Geng, F., & Li, B. (2022). A critical review on interplay between dietary fibers and gut microbiota. Trends in Food Science & Technology, 124, 237-249.*

[15] *Burke, L. M., Cox, G. R., Cummings, N. K., & Desbrow, B. (2001). Guidelines for daily carbohydrate intake: do athletes achieve them?. Sports medicine, 31, 267-299.*

[16] *Hall, K. D., & Kahan, S. (2018). Maintenance of lost weight and long-term management of obesity. Medical Clinics, 102(1), 183-197.*

[17] *Adamski, M., Gibson, S., Leech, M., & Truby, H. (2018). Are doctors nutritionists? What is the role of doctors in providing nutrition advice?.*