

The Application of Anti-inflammatory Diet Patterns in Weight Control of Obese Population: Mechanism and Clinical Manifestations

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Abstract. Obesity is now a serious public health problem worldwide, which is closely related to chronic low-degree inflammation and metabolic disorders. Over recent decades, people have been paying increasing attention to the anti-inflammatory diet in obesity management. This review summarizes the potential mechanism and clinical effect of anti-inflammatory diet in weight control of obese people. The relevant research on the anti-inflammatory diet pattern, mainly the Mediterranean diet (Med) and Dietary Approaches to Stop Hypertension (DASH) were analyzed. Current studies show that anti-inflammatory dietary patterns are very useful to improve obesity by reducing the level of inflammatory factors, enhancing insulin sensitivity, improving adipose tissue function, regulating intestinal microbiota and promoting energy metabolism. In addition, some clinical studies suggest that long-term adherence to an anti-inflammatory diet is linked to lower body mass index (BMI), and it can reduce visceral adipose tissue (VAT) accumulation and improve metabolic health. These findings show that an anti-inflammatory diet may help control weight and prevent obesity-related complications. Overall, an anti-inflammatory diet provides a practical and sustainable way to prevent and manage obesity. However, the optimal components of anti-inflammatory diets and their effects in different populations remain unclear. Research needs to be further carefully designed, with larger populations and longer-term follow-up periods to provide stronger evidence for its clinical application.

Keywords: Obesity; Anti-inflammatory diet; Mediterranean diet; Inflammation; Weight management.

1. Introduction

Obesity is a chronic metabolic disorder, which means the long-term disproportion of energy uptake and consumption, and then it will lead to superfluous accumulation of fat in the body. Body mass index (BMI) is usually used as the evaluation criterion. In recent years, with changes in lifestyle and diet structure, the probability of obesity has been increasing, which has developed into a critical public health issue globally. Especially in America, where 69% of adults are overweight or obese [1]. However, several studies have indicated that inflammation related to metabolism, a chronic low-grade systemic inflammatory condition induced by excessive fatty tissue accumulation, is very important to the pathogenesis of obesity by impairing metabolic homeostasis [2]. Obesity not only affects appearance but also has a great impact on health. Long-term obesity will greatly lead to a higher possibility of developing type 2 diabetes, hypertension, cardiovascular and cerebrovascular disorder, fatty liver disease, and even cancers. It will also bring additional burdens to the joints and respiratory system, seriously affecting the quality of life. Effective weight control has become an indispensable measure for obese people to reduce complications and improve their quality of life.

However, the existing weight control methods have many disadvantages. For example, the drug orlistat, which plays a role in weight control by inhibiting fat absorption, often causes gastrointestinal adverse reactions such as diarrhea and abdominal distension. Some drug inhibitors, such as sibutramine, although they can promote weight loss, have been withdrawn from the European and American markets since 2010 due to the increased risk of cardiovascular events. Exercise intervention is an important part of obesity management, but the effect of weight loss solely through exercise is relatively limited. A systematic review shows that overweight or obese adults lose an average of about 2 to 3 kilograms through aerobic exercise intervention alone, and the weight loss is usually lower

than that of simple diet control or diet combined with exercise intervention [3]. In addition, adhering to regular exercise for a long-time places high demands on an individual's time investment, self-discipline and physical condition, and the compliance is generally low. When the exercise intervention is interrupted, energy expenditure decreases, and some people are prone to weight regain. Therefore, seeking safe and sustainable intervention strategies has become an important direction in obesity prevention research.

Diet has a great influence on the unfolding of obesity. For instance, a pro-inflammatory diet high in sugar and fat can activate inflammatory responses, affect the function of adipose tissue and the homeostasis of intestinal flora, thereby leading to metabolic disorders in the body. By contrast, an anti-inflammatory diet is a dietary habit that can reduce inflammatory activity in the body and improve metabolic state. Its main feature is eating more vegetables, fish, whole grains, nuts, legumes, fruits and unsaturated fatty acids, along with a reduced intake of highly processed foods, fats high in saturation and processed sugar. The Med diet and Dietary Approaches to Stop Hypertension (DASH) diet are also considered common anti-inflammatory diets. This type of diet is rich in active ingredients such as dietary fiber, polyphenols, vitamins and omega-3 polyunsaturated fatty acids. It can slow the onset and progression of obesity by reducing oxidative stress, regulating inflammatory responses, improving the structure of intestinal flora and promoting the balance of energy metabolism. Meanwhile, the Dietary Inflammatory Index (DII) is a commonly used indicator for evaluating the dietary inflammatory potential (DIP). DII scores different foods and nutrients based on their effects on inflammatory factors to determine the pro-inflammatory or anti-inflammatory characteristics of a diet. The lower the DII score, the more anti-inflammatory the diet is. On this basis, the energy-adjusted Dietary Inflammatory Index (E-DII) was further designed to correct for the influence of total energy intake and could more accurately assess the dietary inflammatory levels of different populations. At present, DII and E-DII have been widely applied in research on the relationship between diet and obesity, metabolic syndrome and chronic diseases.

At present, growing evidence has highlighted the importance of the extent to which diet is associated with obesity. Different research results may vary, and the specific mechanism of action and the effects of long-term intervention have not been fully clarified yet. Therefore, this article aims to review the main types of anti-inflammatory dietary patterns, their mechanisms of action, and their relationship with the occurrence and development of obesity, offering a basis for research on dietary strategies to tackle obesity.

2. Mechanisms of Anti-Inflammatory Diet Intervention in Obesity

2.1. Regulation of Inflammatory Responses and Signaling Pathways via Anti-Inflammatory Diets

Chronic low-grade inflammation is considered to be a key pathological basis for the occurrence and development of obesity [4]. In the state of obesity, a large amount of adipose tissue, especially VAT, accumulates. In the past, it was thought that adipose tissue was only a place for the body to store energy. But in recent years, it has been found that it is also a crucial organ with endocrine and immunomodulatory functions. With the continuous enlargement of fat cells, adipose tissue is prone to changes such as hypoxia, oxidative damage, and immune cell infiltration, thus inducing the body to form a persistent chronic low-grade inflammatory state [5]. Activated immune cells continuously release inflammatory factors such as tumor necrosis factor- α (TNF- α), interleukin-6 (IL-6), and C-reactive protein (CRP), thereby forming a chronic systemic low-grade inflammation [6]. These inflammatory factors can interfere with the insulin signal transduction pathway and reduce insulin sensitivity, thereby triggering insulin resistance and abnormal glucose and lipid metabolism. Under insulin resistance conditions, the human body exhibits diminished capacity for glucose utilization. At the same time, liver fat synthesis increases and fat decomposition is inhibited, which eventually leads to further fat accumulation.

Anti-inflammatory diets can improve the above pathological processes by regulating inflammatory responses. The anti-inflammatory diet is abundant in dietary fiber, polyphenols, omega-3 fatty acids and other ingredients, which may lower the secretion of inflammatory factors and suppress the activation of inflammation-associated signaling cascades. Some studies have pointed out that a high-fat diet promotes the increased expression of inflammatory factors such as TNF- α and IL-6 in adipose tissue, and the level of inflammation can be significantly reduced after increasing the intake of unsaturated fatty acids and plant foods [7].

A randomized controlled study in 2023 included 72 overweight and obese adults ($n=72$). After 8 weeks of anti-inflammatory dietary intervention, the levels of inflammatory markers in the subjects showed significant improvement. Among them, the level of IL-6 decreased by about 18% compared with that before the intervention, and the TNF- α decreased by approximately 12%. At the same time, BMI and waist circumference also decreased to varying degrees ($P < 0.05$). According to the study, this might be related to the fact that the anti-inflammatory diet is rich in dietary fiber, unsaturated fatty acids, and polyphenols, which can reduce chronic low-grade inflammation in the body to a certain extent, thereby improving metabolic abnormalities associated with obesity [6]. This shows that the active ingredients in an anti-inflammatory diet may improve obesity-related metabolic disorders by regulating inflammatory pathways.

2.2. Functional Improvement of Adipose Tissue

In the past, it was generally believed that adipose tissue was just a "warehouse" for storing energy, but recent studies have found that adipose tissue is actually an important organ with endocrine and immune regulatory functions. Under the condition of obesity, with the continuous enlargement of fat cells, adipose tissue is prone to changes such as local hypoxia, oxidative stress, and inflammatory cell infiltration, among other changes, which are easy to form a persistent inflammatory microenvironment and impair adipose tissue function. Abnormal adipose tissue will continue to release pro-inflammatory factors and reduce the secretion of beneficial adipokines, thus further aggravating abnormal fat metabolism.

Anti-inflammatory diets can improve the function of adipose tissue to a certain extent. It can alleviate oxidative stress responses, reduce inflammatory reactions in adipose tissue, and promote the recovery of adipocyte metabolic functions. In addition, an anti-inflammatory diet can enhance insulin sensitivity, improve the utilization of glucose and fatty acids by adipose tissue, and reduce abnormal fat accumulation [8].

2.3. Regulation of Intestinal Flora and Metabolic Homeostasis

In recent years, the "gut microbiota-adipose tissue axis" has gradually become a hot topic in obesity research. Intestinal flora disorder not only affects the absorption and utilization of energy but also may lead to damage to the intestinal barrier function, causing metabolic endotoxins such as lipopolysaccharides to enter the circulatory system and inducing systemic inflammatory responses. The persistent inflammatory state can further promote insulin resistance and abnormal lipid metabolism, thereby aggravating the development of obesity and related metabolic diseases.

Anti-inflammatory diets can improve metabolic homeostasis through the gut microbiota. The dietary fiber and plant-derived bioactive components therein can stimulate the expansion of advantageous bacteria, thereby improving intestinal barrier function and metabolic status [7]. A study in 2023 found that the average BMI of obese patients decreased by about 9.2% after 12 weeks of dietary intervention, and the intestinal flora composition and metabolic function also changed significantly [9]. This shows that an anti-inflammatory diet may further improve obesity-related metabolic abnormalities by regulating intestinal flora.

2.4. Regulation of Energy Metabolism and Appetite

The occurrence of obesity is essentially related to long-term energy intake exceeding energy expenditure, and the imbalance of appetite regulation and abnormal energy metabolism are important

factors leading to energy excess. A diet high in sugar, fat, and energy density is likely to reduce satiety and raise overall caloric consumption. At the same time, it may also affect the normal functions of energy-regulating hormones such as leptin and insulin, leading to disruption of the body's energy balance, weight gain, and fat accumulation.

Anti-inflammatory diets can participate in obesity management by affecting energy metabolism and appetite regulation. On the one hand, high dietary fiber foods can delay stomach emptying and enhance a feeling of fullness, thus reducing energy intake. Unsaturated fatty acids and some plant active ingredients may improve obesity by promoting fat oxidation and increasing energy consumption [10]. Animal experiments showed that after an anti-inflammatory diet intervention, the weight gain rate of mice on a high-fat diet decreased by approximately 35.8%, and insulin sensitivity improved significantly [8]. These results suggest that an anti-inflammatory dietary pattern can not only attenuate systemic inflammation but also have a long-term impact on the occurrence and development of obesity by regulating the body's energy metabolism and appetite control.

3. The Clinical Effect of Long-Term Intervention of Anti-Inflammatory Diet on Obesity

The ATTICA study followed up 1,582 Greek adults for 20 years to explore the relationship between adherence to the Med diet and long-term body weight changes. ATTICA evaluated the eating habits and changes in BMI of the subjects through multiple follow-ups and used MedDietScore to assess the compliance with the Med diet [11]. The research results show that the greater adherence to the Med diet corresponds to lower long-term BMI level. Compared with people who deviated from the Med diet pattern for a long time, those who maintained or approached the Med diet pattern during follow-up over the next 10 and 20 years had significantly lower BMI and average BMI after 20 years, and the risk of maintaining an overweight or obese state for a long time decreased by more than 90%. Even though the dietary compliance of some subjects declined in the later stage, the overall effect of weight control remained favorable. Research suggests that the Med diet contains abundant unsaturated fats, fiber and antioxidant substances, which can support long-term weight management by reducing chronic inflammatory responses, improving insulin sensitivity and metabolic function. The findings from this study provide meaningful epidemiological evidence that anti-inflammatory diets can be effective when used as a sustained intervention for obesity (Table 1).

In addition to the ATTICA study, a number of randomized controlled trials in recent years have further confirmed the positive role of anti-inflammatory diets in the long-term management of obesity. The PREDIMED-Plus study was a large-scale multicenter randomized controlled clinical study involving adults with obesity or overweight diagnosed with metabolic syndrome. The subjects were followed up over a long period through a calorie-restricted Med diet combined with exercise intervention. The research results show that compared with the conventional dietary advice group, the intervention group demonstrated more significant reduction in overall fat content and VAT after 1 and 3 years of follow-up, while better maintaining their lean body mass. Notably, the reduction in VAT showed a greater increase compared with the control arm, and VAT is regarded as an important foundation in cases of persistent low-grade inflammation and impaired insulin sensitivity. And the Med diet can reduce the metabolic risks related to obesity and promote long-term weight management by lowering inflammation levels, improving insulin sensitivity and reducing VAT accumulation. This study shows that an anti-inflammatory diet not only helps reduce weight but also improves the body composition of obese patients, reducing the accumulation of VAT, which is linked to high metabolic risk, which is of great significance for preventing obesity-related complications [4].

In 2022, Hernando-Redondo et al. performed a randomized controlled clinical trial, including patients with metabolic syndrome, to assess metabolic changes over the medium and long term in response to a Med diet intervention. The research found that after dietary intervention, the subjects' weight, BMI and waist circumference decreased, and the inflammatory and metabolic indicators related to obesity, such as Leptin and plasminogen activator inhibitor-1 (PAI-1), improved

significantly. Researchers believe that the Med diet can not only promote weight loss but also improve the metabolic state of obese patients by regulating satiety-related hormones and reducing inflammatory reactions. This study suggests that the effect of an anti-inflammatory diet is not only reflected in short-term weight loss but may also promote long-term weight management by improving the body's metabolic environment.

In addition, DIRECT PLUS RCT further explored the sustained effects of the Green Mediterranean diet rich in polyphenol on obesity. This study continued to intervene for 18 months. The findings indicated that the reduction of VAT in the green Med diet group was significantly higher than that in the traditional Med diet group, on the basis of weight and waist circumference reduction, and the reduction in VAT was about twice that of the traditional Med diet group. The study believes that this effect may be related to higher levels of polyphenol intake and lower consumption of red meat in the green Med diet. Polyphenolic substances have strong antioxidants and anti-inflammatory effects. They can reduce the abnormal accumulation of VAT by regulating inflammatory responses in adipose tissue, improving the composition of intestinal flora, promoting fat oxidation, and affecting the energy metabolism-related gene expression. The study also found that the green Med diet can affect the epigenetic and transcription regulatory pathways associated with obesity and metabolic regulation and improve the metabolic environment of the body at the molecular level. The results show that the anti-inflammatory diet characterized by polyphenolic active ingredients not only helps to reduce weight but also can play a continuous intervention role in the key link in the occurrence and development of obesity-VAT accumulation and chronic inflammation, providing new clinical evidence for the long-term prevention and treatment of obesity [3].

Table 1: Key clinical research data on anti-inflammatory diet intervention for obesity

Research Title	Sample size (n)	Intervention measures and duration	Main data results	Ref.
ATTICA	1582	Mediterranean Diet compliance assessment, 20-year follow-up observation	Long-term adherence to the Mediterranean diet (20 years) reduced overweight/obesity risk by >90% and was associated with significantly lower BMI.	[11]
PREDIMED-Plus	1521	Low-calorie Mediterranean diet combined with physical activity, 3-year follow-up	The overall fat content in the intervention group was much lower than that in the control group.	[4]
DIRECT PLUS	294	Green Mediterranean diet, 18-month intervention	The green Mediterranean diet reduced body weight, about twice the reduction observed with the traditional Mediterranean diet	[3]

4. Conclusion

This article, through a review of relevant studies, finds that anti-inflammatory dietary patterns have demonstrated multiple positive effects in obesity management. They can alleviate insulin resistance by reducing the levels of inflammatory factors and also have a positive impact on obesity-related metabolic abnormalities through improving adipose tissue function, regulating intestinal flora and promoting energy metabolism. Meanwhile, the results of multiple clinical studies have shown that adhering to an anti-inflammatory diet for a long time can help lower BMI, improve weight control outcomes, and lower the likelihood of obesity. In addition, anti-inflammatory diets can enhance weight loss effects by alleviating oxidative stress and regulating lipid metabolism, and the synergistic interplay among these mechanisms offers a more comprehensive strategy for obesity management. Long-term adherence to such dietary patterns also helps improve patients' overall inflammatory status, thereby reducing the risk of complications.

Overall, anti-inflammatory diets, as a safe, economical and easy to adhere to lifestyle intervention measure in the long term, have a promising application potential in the prevention and management of obesity. However, the optimal proportions of specific anti-inflammatory components and the health benefits of personalized interventions for obese individuals across different ages and genetic backgrounds remain to be further explored. In the future, more clinical studies with rigorous designs, sufficient sample sizes and longer follow-up periods need to be carried out to provide more thorough scientific evidence for the wide application of anti-inflammatory diets in the prevention and treatment of obesity. These explorations will help further optimize the clinical practice pathways of anti-inflammatory diets and enhance their practical application value in obesity prevention and treatment.

References

- [1] Busebee, B., Ghush, W., Cifuentes, L., et al. Obesity: A Review of Pathophysiology and Classification. *Mayo Clinic Proceedings*, 2023, 98(12): 1842-1857.
- [2] Cheong, L.Y.T., Saipuljumri, E.N., Loi, G.W.Z., et al. Autolysosomal Dysfunction in Obesity-induced Metabolic Inflammation and Related Disorders. *Current Obesity Reports*, 2025, 14(1): 43.
- [3] Jayedi, A., Soltani, S., Emadi, A., et al. Aerobic Exercise and Weight Loss in Adults: A Systematic Review and Dose-Response Meta-Analysis. *JAMA Network Open*, 2024, 7(12): e2452185.
- [4] van de Vyver, M. Immunology of chronic low-grade inflammation: relationship with metabolic function. *Journal of Endocrinology*, 2023, 257(1): e220271.
- [5] Mora, A.L., Bueno, M., Rojas, M., et al. Mitochondria in the spotlight of aging and idiopathic pulmonary fibrosis. *Journal of Clinical Investigation*, 2017, 127(2): 405-414.
- [6] de Mello, R.N., de Gois, B.P., Kravchychyn, A.C.P., et al. Dietary inflammatory index and its relation to the pathophysiological aspects of obesity: a narrative review. *Archives of Endocrinology and Metabolism*, 2023, 67(6): e000631.
- [7] Wang, C., Yi, Z., Jiao, Y., et al. Gut Microbiota and Adipose Tissue Microenvironment Interactions in Obesity. *Metabolites*, 2023, 13(7): 821.
- [8] Chasman, D.I., Posada, D., Subrahmanyam, L., et al. Pharmacogenetic study of statin therapy and cholesterol reduction. *JAMA*, 2004, 291(23): 2821-2827.
- [9] Wang, H., Lv, X., Zhao, S., et al. Weight Loss Promotion in Individuals with Obesity through Gut Microbiota Alterations with a Multiphase Modified Ketogenic Diet. *Nutrients*, 2023, 15(19): 4163.
- [10] Liu, Y., Zhong, W., Li, X., et al. Diets, Gut Microbiota and Metabolites. *Phenomics*, 2023, 3(3): 268-284.
- [11] Damigou, E., Georgoulis, M., Chrysoshoou, C., et al. Mediterranean-Type Diet Adherence and Body Mass Index through 20 Years of Follow-Up: Results from the ATTICA Cohort Study (2002-2022). *Nutrients*, 2024, 16(8): 1128.