Proceedings of ICBioMed 2025 Symposium: Computational Modelling and Simulation for Biology and Medicine
DOI: 10.54254/2753-8818/2025.LD26015

Effect of Mediterranean Diet on Type 2 Diabetes

Yangqi Tan

School of Humanities and Management, Fujian University of Traditional Chinese Medicine, Fuzhou, China
2682E913CB9D581A@outlook.com

Abstract. The incidence rate of type 2 diabetes (T2DM) is on the rise all over the world, and has become an increasingly serious global health problem. At present, people are actively seeking solutions to T2DM and have made many breakthroughs, such as the reversal management model. The role of diet in the treatment of TM2D is also gradually highlighted. There are studies on the impact of various dietary patterns on TM2D. This paper mainly studies the impact of MD on TM2D and explores the impact of the Mediterranean diet (MD) on the special population of T2DM patients and different focus areas. Exploring the relationship between the intervention duration is positively correlated with TM2D. Long-term adherence to TM2D can reduce blood sugar levels, effectively control blood sugar, and prevent various cardiovascular complications by anti-inflammatory, lipid-lowering, and improving insulin sensitivity. This study provides a reference for the preventive treatment and lifestyle intervention the duration of MD intervention and the improvement effect of TM2D. It was found that if TM2D, as well as improving the compliance of TM2D patients with MD, can resolve the limitations of MD that have not yet been resolved. In the future, research can focus on addressing the difficulty of calorie control and the risk of nutrient imbalance in MD, as well as the salt content of some traditional MD, which may lead to high sodium problems.

Keywords: Type 2 diabetes, Mediterranean diet, incidence rate, glucose and lipid metabolism

1. Introduction

Type 2 diabetes (T2DM) is a metabolic disease characterized by abnormal glucose metabolism. It has hidden onset, progressive deterioration, multiple complications, and high disability and mortality rates. With the continuous improvement of people's living standards, T2DM patients are becoming younger and younger. Among T2DM patients, young and middle-aged patients aged 18-60 account for about 59%. This issue may be closely related to people's unhealthy eating patterns in their fast-paced lives, such as the habit of eating high oil and high salt fast food. In the report of the World diabetes Federation (IDF) in 2024, the number of global adult diabetes patients reached 579 million, of which T2DM accounted for 92.3%. With the continuous improvement of the incidence rate of the disease, diabetes patients will reach 693 million by 2045. Today, diabetes has become a global concern [1]. At present, diabetes is a kind of life disease, and there is no treatment plan that

DOI: 10.54254/2753-8818/2025.LD26015

can completely cure T2DM. Only relying on simple drug treatment can not effectively control blood sugar, and it needs reasonable diet to achieve better treatment effect. However, in people's daily lives, their understanding of dietary therapy is still insufficient, and their attention to daily diet and nutrient intake is also very lacking. Less than 10% of people consume whole grains every day, and about 18% of people have never heard about "dietary therapy and dietary supplements". Among various dietary patterns, the Mediterranean diet (MD) is characterized by low fat, high vitamins and fiber, and high quality protein. It mainly consists of fresh fruits and vegetables, fish, and grains, and uses olive oil as the main oil. Olive oil provides monounsaturated fatty acids and phenolic substances, enhancing the body's antioxidant function and reducing glycated hemoglobin (HbA1c). Reducing the intake of red meat can effectively reduce the production of saturated fatty acids in the body, improve glucose and lipid metabolism, and lower blood sugar levels. Several existing studies have shown that the future T2DM incidence rate can be reduced by about 52% through the MD. This article analyzes the changes in the condition of T2DM patients after adopting a MD, mainly exploring the impact of MD on T2DM patients and the improvement effect on blood glucose. It can help people better understand the MD pattern and its impact on human health and TM2D, help patients with T2DM to carry out lifestyle intervention, make up for the lack of TM2D drug treatment, help patients with T2DM and some patients of special age to alleviate the problem of high blood sugar, help patients with blood sugar control, prevent complications, and prevent deterioration. Finally, it is concluded that the MD has a significant effect on reducing fasting and 2-hour postprandial blood glucose levels in patients. The duration of intervention is positively correlated with the improvement of blood glucose levels, and young T2DM patients are more likely to achieve blood glucose stability through the MD due to their faster response to carbohydrates.

2. Characteristics of mediterranean cuisine

2.1. Olive oil

The MD mainly encourages people to replace animal fats with olive oil, which is mainly used for cold dishes, frying and baking, as the core source of fat in the diet. Olive oil is a natural, cold pressed vegetable oil that has not undergone chemical treatment. It is rich in various vitamins and trace elements, and has high nutritional value. The human body's absorption of olive oil can reach 98.4%, making it known as the "most ideal vegetable oil of the 21st century" [2]. Olive oil is rich in unsaturated fatty acids (such as oleic acid), which account for more than 70% of total fat and help reduce low-density lipoprotein (LDL). LDL is the main carrier of cholesterol transport to the blood vessel wall. Strengthening LDL reduction can inhibit plaque rupture and reduce sudden diseases such as myocardial infarction. For every 1mmol/L decrease in LDL-C, the risk of cardiovascular events decreases by 21% and the risk of cardiovascular death decreases by 13%. Secondly, it contains polyphenolic antioxidants that can inhibit the activity of I κ B kinase, prevent the transfer of nuclear factor kappa B to the nucleus, and reduce the transcription of pro-inflammatory cytokine genes. Polyphenols can alter the composition of bile acids and reduce inflammation in the liver and adipose tissue.

2.2. Fresh fruits and vegetables and whole grains

This is a plant-based food in MD, which is the absolute foundation of this diet. It is recommended to consume at least 5 servings of vegetables and fruits per day, preferably fresh seasonal and local products such as tomatoes, spinach, citrus, etc. Fresh fruits and vegetables can provide vitamin C,

DOI: 10.54254/2753-8818/2025.LD26015

potassium, sodium, dietary fiber and antioxidants (such as lycopene and flavonoids), reduce the risk of diabetes through the trinity mechanism of "scavenging free radicals - repairing insulin signals - regulating flora", long-term intake can increase insulin sensitivity by 15% -20%, and reduce the risk of diabetes by 25% [3]. Whole grains mainly include non refined carbohydrates such as whole wheat bread, brown rice, oats, etc. They can be paired with legumes such as chickpeas and beans, which can provide complex carbohydrates and dietary fiber, enhance satiety and maintain intestinal health, and reduce blood sugar fluctuations by 30%. Secondly, nuts and seed based foods are also essential, as they are rich in unsaturated fatty acids, plant protein, and trace elements such as magnesium and zinc, which can reduce blood sugar load, improve insulin sensitivity, and inhibit excessive activation of insulin growth factors.

2.3. High quality white meat

Mainly focusing on fish and seafood, limiting the intake of red meat, which is also the main source of protein for MD. The consumption frequency is greater than or equal to 2 times a week, mainly using steaming and stewing methods for cooking. The heme iron rich in red meat can induce oxidative stress, interfere with insulin signaling pathway, and lead to insulin resistance [4]. Studies have proved that its intake is positively related to the risk of diabetes. Therefore, red meat is strictly limited to a few times a month, with a total amount of less than or equal to 450 grams per month. Lean meat is mainly used. Fish and seafood contain a large amount of long-chain N-3 fatty acids (docosapentaenoic acid, docosahexaenoic acid, EPA, and DHA), which can enhance cell membrane fluidity, promote insulin receptor signaling, and make glucose more easily taken up by muscles and liver. Omega-3 inhibits liver gluconeogenesis, inhibits platelet aggregation, reduces thromboxane production, reduces the risk of cardiovascular complications, and reduces the incidence of cardiovascular events related to diabetes by 14% [5].

2.4. Dairy grade eggs

MD recommends that people consume no more than 4 servings of chicken and eggs per week, and mainly consume low-fat fermented dairy products such as Greek yogurt and cheese. Can provide probiotics and calcium for the human body. Probiotics regulate the intestinal barrier, promote digestion and absorption, and reduce inflammation and insulin resistance caused by endotoxins entering the bloodstream [6]. Calcium ions are key messengers of insulin vesicles, and sufficient calcium intake ensures normal response of beta cells to blood glucose fluctuations. A study in Singapore found that compared with people who don't drink milk, people who drink milk every day have a significantly reduced risk of T2DM by 12%, which may be related to the fact that milk and dairy products are rich in vitamin D or calcium and magnesium ions. Calcium and vitamin D jointly regulate parathyroid hormone to avoid secondary insulin resistance caused by hypocalcemia.

2.5. Drinking and desserts

The use of red wine as a moderate meal companion in MD is somewhat controversial and should follow the principle of moderation: women and men over 65 years old should not exceed 150 ml/d, and men should not exceed 300 ml/d. Within this range, resveratrol can activate the AMPK and SIRT1 pathways, which can enhance the glucose uptake capacity of skeletal muscle and liver, thereby improving insulin sensitivity. The SIRT1 pathway protects beta cell function, inhibits TLRR4 acetylation, blocks NF kB mediated inflammatory response, reduces ceramide synthesis,

DOI: 10.54254/2753-8818/2025.LD26015

and thus alleviates beta cell apoptosis and insulin secretion disorders. AMPK increases NAD^+levels, activates SIRT1, and ultimately promotes AMPK phosphorylation. The two pathways of AMPK and SIRT1 form a positive regulatory loop, synergistically improving T2DM. However, excessive alcohol consumption can increase triglycerides, which requires individualized assessment. Fresh fruits are used as daily desserts for desserts, while refined sugars such as pastries and honey are only served a few times a month.

3. The effect of MD on T2DM

3.1. The improvement of MD on T2DM

Research shows that MD can reduce the risk of diabetes and improve the glucose and lipid metabolism of diabetes patients. In addition, the study also found that long-term MD has a positive effect on the prevention and management of T2DM, which can reduce the incidence of T2DM, the level of glycosylated hemoglobin, and the risk of cardiovascular disease to 20% -23%, 0.3% -0.47%, and 28% -30%, respectively [7]. Kang Dongmei et al. included the pregnant women who were completely normal in fasting blood glucose examination at 8-12 weeks of pregnancy in a stratified and random manner. The diet intervention group adopted the MD structure, and found that their fasting blood glucose, blood glucose level 2 hours after taking sugar, and the incidence of diabetes in pregnancy in the glycosylated hemoglobin and glucose tolerance test were significantly lower than those in the conventional diet group, with a statistically significant difference ($P<0.05$), which confirmed that the improved MD could effectively control the incidence rate of diabetes in pregnancy. The MD structure can reduce the risk of atrial fibrillation, as it is composed of foods rich in anti-inflammatory and antioxidant components, which can significantly reduce the levels of pro-inflammatory cytokines and increase the content of anti-inflammatory cytokines [8]. This diet not only helps reduce the risk of atrial fibrillation, but also improves the sensitivity of peripheral tissues to insulin by inhibiting the over activation of the innate immune system, thereby reducing the risk of diabetes [2].

3.2. Impact of MD on special population with T2DM

3.2.1. Special benefits of MD for elderly patients with T2DM

Elderly patients with T2DM refer to patients with T2DM whose age is ≥ 65 years old. In terms of cardiovascular, elderly patients often have cardiovascular problems such as atherosclerosis and hypertension. Monounsaturated fatty acids (olive oil), Omega-3 (fish) and antioxidants (fruits and vegetables) in MD can significantly improve arterial function. Research shows that adhering to a MD rich in olive oil for 1.5 years can improve arterial blood flow in elderly patients by 30% and reduce the risk of cardiovascular events by about 30%; The MD can promote intestinal health and has anti-inflammatory effects [9]. Due to the imbalance of gut microbiota in elderly patients, dietary fiber and fermented foods in MD can promote beneficial microbiota, improve intestinal barrier function, and indirectly alleviate the damage of chronic inflammation to insulin function; The MD is mild and safe for blood sugar control. Elderly people have decreased insulin sensitivity and are prone to hypoglycemia. The MD mainly consists of low glycemic index foods (whole grains, legumes), supplemented by high fiber, which can stabilize postprandial blood sugar and avoid sudden drops in blood sugar. The Spanish PREDMIMED study confirmed that the decrease in HbA1c in elderly patients after MD was better than that in the low-fat diet group.

DOI: 10.54254/2753-8818/2025.LD26015

3.2.2. Special benefits of MD for young patients with T2DM

Youth T2DM refers to T2DM patients aged 20-65 years. MD can reverse insulin resistance and manage obesity in young patients. Youth T2DM is mostly related to obesity. MD can enhance satiety through high fiber vegetables and whole grains, reduce visceral fat accumulation, and polyphenols in olive oil can activate insulin receptor pathway and directly improve insulin resistance [10]; MD can reduce the risk of pre diabetes transformation, and the intervention effect is better when young people are in pre diabetes. MD can reduce the risk of diabetes by 30% -40%, and protect the genetically susceptible young population better than the elderly; The synergistic regulation of MD metabolic syndrome is better, and young patients often have blood lipid abnormalities (high TG/low HDL-C) [11]. MD can increase density lipoprotein by 10% -15% and reduce triglyceride levels more effectively than a simple low-fat diet. However, elderly people have a smaller improvement in blood lipids due to a decrease in metabolic rate.

4. The relationship between the duration of MD intervention and the improvement effect of T2DM

4.1. Improvement effect of short-term intervention of MD on T2DM

Short term intervention (<1 year) is suitable for newly diagnosed patients and obese individuals with insulin resistance, rapidly improving blood glucose and insulin sensitivity, and reducing blood glucose indicators. After 6 months of MD, the average HbA1c of newly diagnosed T2DM patients decreased by 0.4% -0.7%, mainly due to high fiber foods slowing down sugar absorption and polyphenols in olive oil enhancing insulin sensitivity. A meta-analysis was conducted in a certain study, and the results showed that subgroup analysis was conducted based on the impact of different intervention times on HbA1c [12]. The results showed that there was no statistically significant difference between the intervention time<6 months and the non intervention time, but the difference was statistically significant when the intervention time was ≥ 6 months; When the intervention time is ≥ 12 months, the effect of reducing HbA1c in T2DM patients is better. The MD enhances satiety, reduces calorie intake, and results in an average weight loss of 2-5 kilograms within 3 months, allowing for initial weight control. The monounsaturated fatty acids in olive oil can inhibit the activity of key enzymes involved in fat accumulation and promote fat oxidation.

4.2. The improvement effect of mid-term intervention of MD on T2DM

Mid-term intervention (1-2 years) is suitable for individuals with initially stable blood sugar levels and comprehensive improvement in cardiovascular metabolism. Persisting in MD for 1-2 years can continuously alleviate insulin resistance, further improve beta cell function, and enhance insulin secretion ability; In addition, it can also reduce cardiovascular risk. After continuous intervention for 12-24 months, patients' low-density lipoprotein decreased by about 15%, high-density lipoprotein increased by 10%, and systolic blood pressure decreased by 5-8 mmHg. This effect is due to the anti-inflammatory and endothelial function improvement effects of unsaturated fatty acids.

4.3. The improvement effect of long-term intervention of MD on T2DM

Long term intervention (>3 years) is suitable for people with stable blood glucose relief and high risk of diabetes, with reasonable exercise, aerobic training 3 times a week, resistance training 2 times, and balance training 1 time a week. It can improve the remission rate of diabetes, and about

DOI: 10.54254/2753-8818/2025.LD26015

30% of patients who insist on MD for a long time can achieve remission of diabetes. In addition, it can significantly reduce the risk of complications, with a 25% decrease in cardiovascular event risk and a 20% decrease in neurodegenerative disease risk for individuals with high MD compliance.

5. Conclusion

This study found that the MD has become a powerful tool for the prevention and management of T2DM by anti-inflammatory, lipid-lowering, and improving insulin sensitivity, especially with significant advantages in cardiovascular and cognitive protection.The improvement of T2DM with the MD is time-dependent - short-term glycemic control, mid-term cardioprotection, and long-term remission. Persisting for more than 3 years and combining it with exercise may achieve disease relief and prevention of complications, and its high compliance is the core advantage of sustainable intervention. Therefore, the duration of MD intervention is positively related to the improvement of T2DM. Adhering to MD for a long time and developing it into a lifestyle diet can not only effectively control the condition of T2DM, but also effectively prevent various complications, reduce the incidence rate and mortality of T2DM, and improve the quality of life of patients. However, MD has not yet been able to replace the drug treatment of T2DM, and there are some shortcomings, such as difficulty in calorie control, risk of nutrient imbalance, and salt content in some traditional Mediterranean dishes, which may cause high sodium problems. The future MD should be combined with personalized adjustments, biomarker monitoring, and localized improvements to make it a more universal and safe dietary pattern.

References

[1] Zhang, K., Sun, H., Liu, X., et al. (2022). Meta-analysis of the effect of Mediterranean diet on blood glucose level in patients with type 2 diabetes. China Clinical Research, 35(02), 157–161.
[2] Lu, B., & Jiang, Y. (2025). Research progress on the relationship between diet and the occurrence of type 2 diabetes. Clinical Medical Research and Practice, 10(02), 189–192.
[3] Hu, L., Cai, H., Tang, L., et al. (2023). Research progress on the effect of Mediterranean diet on metabolic related diseases. Medical Information, 36(22), 183–188.
[4] Liu, G., Chen, Y., Fu, Y., et al. (2018). Research progress on the influence of different dietary structures on type 2 diabetes. Preventive Medicine, 30(05), 498–501.
[5] Dehghani, S., Karimi, P., Tarei, N. N., et al. (2025). Comparison of the effect of intermittent fasting with Mediterranean diet on glycemic, lipid, and anthropometric indices in type 2 diabetes: A review of randomized controlled trials. Current Hypertension Reviews.
[6] Özkan, Ö. G., Çetetoğlu, B., Temiz, B., et al. (2024). The effect of eating motivation on adherence to the Mediterranean diet, glycemia and lipid profile in individuals with type 2 diabetes. International Journal of Environmental Health Research, 35(1), 11–12.
[7] Alam, M. M., Nureen, N. E. N., Bhowmik, S., et al. (2024). Association between Mediterranean diet adherence and dyslipidemia among type 2 diabetes mellitus patients in Dhaka, Bangladesh: A hospital-based study. Discover Public Health, 21(1), 145.
[8] García, Z. S., Gregori, B. J. F. J., Ortiga, S. R., et al. (2024). Association between Mediterranean diet adherence and peripheral artery disease in type 2 diabetes mellitus: An observational study. Journal of Diabetes and Its Complications, 38(11), 108871.
[9] Alicia, H. P., P. A. L. D. A., M. F. M. G., et al. (2024). Mediterranean diet as a strategy for preserving kidney function in patients with coronary heart disease with type 2 diabetes and obesity: A secondary analysis of CORDIOPREV randomized controlled trial. Nutrition & Diabetes, 14(1), 27.
[10] Zheng, X., Zhang, W., Wan, X., et al. (2024). The effects of Mediterranean diet on cardiovascular risk factors, glycemic control and weight loss in patients with type 2 diabetes: A meta-analysis. BMC Nutrition, 10(1), 59.
[11] Pavlidou, E., Papadopoulou, K. S., Fasoulas, A., et al. (2023). Diabesity and dietary interventions: Evaluating the impact of Mediterranean diet and other types of diets on obesity and type 2 diabetes management. Nutrients, 16(1).

DOI: 10.54254/2753-8818/2025.LD26015

[12] K., E., B., D. R., C., L., et al. (2023). High vs low adherence to the Mediterranean diet for prevention of diabetes mellitus type 2: A systematic review and meta-analysis. Clinical Nutrition ESPEN, 58, 556–556.