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Research Article

The Effect of Practicing Twenty-Four Forms of Tai Chi on Functional Constipation in T2DM and Mechanism

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Abstract

Background: Little is known about the effect of practicing 24-style Tai Chi on functional constipation in type 2 diabetes mellitus and its mechanism. We hypothesized that 24-style Tai Chi could improve functional constipation in T2DM patients.

Material & methods: 60 T2DM patients with Functional Constipation (FC) will be allocated into the Tai Chi and aerobic exercise groups. The two groups will receive 12 weeks of Tai Chi or aerobic exercise.After 12 weeks of intervention, the PAC-SYM (Patient Assessment of Constipation Symptoms) score, Body Mass Index (BMI), Fasting Blood Glucose (FBG), insulin resistance index (HOMA-IR), glycosylated hemoglobin (HbA1c) were compared among the two groups.

Results: The Tai Chi group showed significant improvement in PAC-SYM scores. Tai Chi intervention effectively reduced HbA1c and FBG levels, and in both groups, before and after the intervention, there was no significant change in HOMA-IR. The B coefficient relationship between PAC-SYM scores and BMI was significant in the aerobic exercise group both before and after adjusting for modeling.

Conclusion: The significant reduction of PAC-SYM scores in the Tai Chi group after improving metabolic indexes suggests that Tai Chi significantly alleviates constipation symptoms in T2DM .

Keywords: 24-style Tai Chi, Aerobic exercise, Constipation; PAC-SYM, Type 2 diabetes mellitus

Introduction

The development of type 2 Diabetes Mellitus (T2DM) is associated with various factors, including genetics, environment, and lifestyle. Its main pathophysiological feature is the relative insufficiency of insulin secretion and/or impaired insulin action, which leads to an imbalance in glucose regulation and a sustained elevation of blood glucose levels. A prolonged hyperglycemic state will cause damage to multiple organ systems of the human body [1]. With the accelerated incidence of diabetes worldwide and the aging of the population, the study of diabetes and its complications has received more and more attention, among which the alteration of gastrointestinal function and structure in diabetic patients has become one of the hotspots of research. In particular, diabetic

constipation is a complication whose pathogenesis is complex, and the specific details have not been fully clarified yet [2-5]. In diabetes management, it is crucial to personalize the glycemic control strategies that aim to minimize the complications that may arise from diabetes and significantly reduce the financial burden they and their families face. In addition to traditional medication, physical activity is increasingly vital in diabetes management as a non-pharmacological treatment. Physical activity has a significant positive impact on the control of blood glucose levels and can help patients better manage their diabetes. In addition, physical activity has been shown to reduce morbidity and mortality and improve insulin sensitivity in these patients [6,7].

Tai Chi, a physical and mental workout that originated in China and has become popular worldwide, offers an ideal workout option for people of all ages with its low to moderate intensity. For people with T2DM, Tai Chi demonstrates unique health benefits [8]. Results from a national health survey in the United States showed that Tai Chi stood out among several complementary therapies as one of the top three most popular therapies [9]. This finding not only highlights Tai Chi's popularity but also demonstrates its general effectiveness in promoting health. Of particular importance is that no serious adverse events were associated with Tai Chi, which provides an important safety net for its use in diabetes management [10,11]. Tai Chi demonstrates similarities with common exercise modalities in several dimensions regarding health benefits. It promotes a moderate increase in resting energy expenditure, contributing to weight management and body composition [12,13]. At the same time, Tai Chi improves aerobic fitness [14]. It enhances cardiorespiratory fitness, which is particularly important for diabetic patients, as cardiovascular disease is one of the common complications of diabetes [15]. In addition, Tai Chi improves self-perceived health, helping patients develop a more positive attitude toward life and health [16]. However, it is worth noting that Tai Chi performs relatively mildly in terms of energy metabolism [17]. This means it does not place an excessive physical burden on patients, reducing the risk of exercise injury. For T2DM patients, this low-intensity form of exercise is more likely to be accepted and adhered to, resulting in a greater likelihood of long-term health benefits. Therefore, in diabetes management, we should actively promote Tai Chi and encourage patients to incorporate it into their daily health management programs.

As a traditional form of health-improving exercise, 24-style Tai Chi nourishes the body in tranquility. It realizes the effect of internal and external cultivation and the unity of body and mind through slow, coherent, round, and soft movements and the coordination of breathing and movements. During the practice of Tai Chi, every move and every style contains a wealth of wisdom for health maintenance, in which lightness and calmness go hand in hand, and emptiness and realism are born together. Such movement characteristics significantly mobilize many organs of the whole body, promote the circulation of qi and blood, and regulate and improve the function of the digestive and circulatory systems [18,19]. Little is known about the effect of practicing 24-style Tai Chi on functional constipation in type 2 diabetes mellitus and its mechanism. We hypothesized that 24-style Tai Chi could improve functional constipation in T2DM patients. By analyzing this relationship in depth, we expect to provide more scientific and practical guidance, improving their overall health and quality of life.

Method

Study Participants

60 T2DM patients with functional constipation (FC) will be allocated into the Tai Chi and aerobic exercise groups. The two groups will receive 12 weeks of Tai Chi or aerobic exercise. Recruitment for this study is from April 1, 2024 to June 1, 2024. Inclusion criteria: individuals aged 55-75 years at the beginning of the study; Body Mass Index (BMI) 23.0-29.9 kg/m^2; and meet the Rome IV Diagnostic Criteria for FC [20], including two or more symptoms of the following: (i) more than 25% of bowel movements require straining; (ii) more than 25% of bowel movements have lumpy or hard stools; (iii) more than one-quarter (25%) of bowel movements feel incomplete; (iv) more than one-quarter (25%) of bowel movements feel like an obstruction or blockage in the rectum or anus; (v) more than one-quarter (25%) of bowel movements need to be manually assisted; and (vi) spontaneous weekly bowel movements less than three times. The exclusion criteria included using systemic antibiotics or antimycobacterial drugs within 30 days before the study and antidiarrheal or laxative medications within 30 days. The investigator is unsure of the subject's willingness or ability to comply with protocol requirements. Subjects with milk protein allergy, lactose intolerance, organic constipation, or neurologic constipation. Pregnant or lactating women; severe cardiovascular, neurologic, psychiatric, or renal disease; gastrointestinal dynamics, non-steroidal anti-inflammatory drugs, and steroids within the past 15 months.

An informed consent was obtained from all subjects enrolled in the study, written consents for this study were obtained from all enrolled patients and the Ethics Committee of Shanghai Yangpu Shidong Hospital approved the study (2024-013-01).

Study Design

The Tai Chi group performed aerobic 24-style Simplified Tai Chi exercise three times a week, lasting 60-90 minutes with 15 minutes of warm-up and cool-down included. The 24-style Simplified Tai Chi Forms are based on Tai Chi's main styles and characteristics

and the selection and simplifying of representative movements. Two professional Tai Chi instructors with over ten years of training experience conducted the training. They have mastered the profound theoretical knowledge of Tai Chi and accumulated rich practical experience. They can demonstrate each movement accurately and deeply understand the various problems that the students may encounter in practice to help them better understand the philosophical ideas of Tai Chi and thus reach a higher level on the technical level.

The aerobics group performs the ninth set of broadcasting gymnastics training. The radio-gymnastics intervention lasted 1 hour, with the first 15 minutes for warm-up, 30 minutes of radio-gymnastics intervention, and the last 15 minutes for relaxation. Training was conducted five times/week, Monday through Friday, with two days of rest per week for 12 consecutive weeks. The routine usually consists of a preparation section, basic gymnastics, jumping movements, and a finishing section that provides a comprehensive workout of coordination, balance, and endurance. The PAC-SYM (Patient Assessment of Constipation Symptoms) score was used to assess the severity of constipation. In this scale, each item is rated using a 4-point scale with four levels, where higher scores represent more severe symptoms [21]. The primary outcome of the study was the change in the PAC-SYM score. This scoring system aims to provide a more comprehensive understanding of the patient's constipation symptoms, including their specific abdominal manifestations, rectum, and fecal output. By comparing the PAC-SYM scores before and after treatment, it is possible to assess the extent to which the treatment has improved the symptoms of constipation, thus guiding clinical treatment.

General clinical information [gender, age, Waist Circumference (WC), height, weight, blood pressure] was collected from the medical history. Blood measurements included fasting Blood Glucose (FBG), fasting C-peptide, fasting insulin, Glycosylated Hemoglobin (HbA1c), Total Cholesterol (TC), Triglycerides (TG), Low-Density Lipoprotein Cholesterol (LDL-C), High-Density Lipoprotein Cholesterol (HDL-C), Alanine Aminotransferase (ALT), Aspartate Aminotransferase (AST), Uric Acid (UA), Creatinine (Cr), Urea Nitrogen (BUN). Body Mass Index (BMI) is determined by the formula weight (kg)/height $(m)^2$.

Statistical Analysis

Data were reported as the mean ± Standard Deviation (SD). Statistical analyses were performed using SPSS Version 26 (IBM Corp, Armonk, NY, USA). The Wilcoxon signed-rank test was used to compare data between visits, and the Wilcoxon rank-sum test was used to compare groups for PAC-SYM. Paired t-test was used to compare the blood glucose levels before and after the intervention. Two independent sample t-tests were used to compare baseline and intervention data between groups. The association between the percentage of baseline constipation-symptom (PAC-SYM) scores and anthropometric indicators of glucose metabolism before and after exercise was investigated through linear regression analysis. $p < 0.05$ was considered an indication of statistically significant differences.

Result

Table 1 presents the study participants' baseline characteristics. Table 2 presents data on the assessment of abdominal symptoms, rectal symptoms, and fecal symptoms in the Tai Chi and aerobic exercise groups before and after exercise. After the intervention, abdominal discomfort was significantly reduced in both Tai Chi and aerobic exercise groups. This suggests that both exercises are practical in improving symptoms of abdominal discomfort. The Tai Chi group showed significant improvement in bloating symptoms after the intervention, while the aerobic exercise group showed no significant change. Although the Tai Chi group showed a slight reduction in painful defecation symptoms after the intervention, while the aerobic exercise group showed a significant decrease, the difference between the groups was insignificant. Both the Tai Chi and aerobic exercise groups showed significant improvement in the feeling of incomplete defecation, bowel movements that were too hard, and bowel movements that were too small after the intervention, and the improvement was more significant in the Tai Chi group. The Tai Chi group showed more significant improvement in symptoms such as small stool volume, having to squeeze hard to defecate, and having the urge to defecate but not being able to do so.

Characteristic	Taiji group	Aerobic exercise group
Age, years	64±7	62±5
Sex, number (%)		
Male	18 (60)	16 (53)
Female	12 (40)	14 (47)
Weight (kg)	67.6 ± 6.0	67.4 ± 3.8
WC (cm)	93.1 ± 11.6	100.2 ± 14.9
Body mass index (kg/m^2)	24.4 ± 1.9	25.2 ± 2.2
HOMA-IR (mu/l)	1.93 ± 0.47	2.16 ± 0.83
HbA1C (%)	8.09 ± 0.65	7.93 ± 0.72
C-peptide (ng/ml)	2.93 ± 0.58	3.13 ± 0.92
FBG (mmol/l)	8.67 ± 1.23	9.01 ± 1.00
Total cholesterol (mmol/L)	6.91 ± 1.41	5.98 ± 1.29
Triglyceride (mmol/L)	2.88 ± 0.54	2.57 ± 0.84
LDL cholesterol (mmol/L)	4.27 ± 0.47	3.67 ± 0.79
HDL cholesterol (mmol/L)	1.25 ± 0.19	1.49 ± 0.32

Notes: WC: Waist Circumference; Hba1c: Glycated Hemoglobin; FBG: Fasting Blood Glucose; LDL: Low Density Lipoprotein; HDL: High Density Lipoprotein

Table 1: Baseline Characteristics of the Participants.

	Item	Tai Chi group (before intervention)	Aerobic exercise group (before intervention)	Tai Chi group (after intervention)	Aerobic exercise group (after intervention)	p-Value[a]
Abdominal symptoms	1.Discomfort in abdomen	1.17 ± 0.67	1.09 ± 0.55	0.72 ± 0.73 #	0.65 ± 0.48 *	0.034
	2.Pain in abdomen	0.59 ± 0.23	0.78 ± 0.63	0.55 ± 0.38	0.69 ± 0.58	
	3.Bloating in abdomen	0.88 ± 0.62	0.98 ± 0.75	0.61 ± 0.33 #	0.94 ± 0.69	
	4.Stomach cramps	0.87 ± 0.81	0.73 ± 0.47	0.88 ± 0.91	0.69 ± 0.51	
Rectal symptoms	5.Painful bowel movement	0.94 ± 0.99	1.05 ± 0.78	0.91 ± 0.88	0.57 ± 0.94 *	0.482
	6.Rectal burning during or after a bowel movement	0.62 ± 0.47	0.71 ± 0.74	0.60 ± 0.51	0.67 ± 0.72	
	7.Rectal tearing or bleeding After a bowel movement	1.16 ± 0.61	1.33 ± 1.18	1.18 ± 0.26	1.29 ± 0.88	
Stool symptoms	8.Incomplete bowel movement, like you didn't "finish"	1.36 ± 1.08	1.29 ± 0.99	0.83 ± 0.96 #	0.95 ± 0.69 *	0.026
	9.Bowel movement that were too hard	1.84 ± 1.12	1.80 ± 0.94	1.02 ± 0.99 #	1.23 ± 0.72 *&	
	10.Bowel movement that were too small	1.97 ± 1.62	1.99 ± 1.38	1.21 ± 0.49 #	1.33 ± 1.71 *&	
	11.Straining or squeezing to try To pass bowel movements	1.44 ± 1.09	1.51 ± 0.92	0.84 ± 0.73 #	1.49 ± 0.81	
	12. Feeling like you had to pass a bowel movement you couldn't	1.37 ± 0.52	1.39 ± 0.45	0.83 ± 0.52 #	0.91 ± 0.68 *&	
	Total scores	14.66 ± 9.89	14.51 ± 10.03	8.95 ± 7.76	7.51 ± 6.83	0.067

*p<0.05,comparisons with V1values in the Aerobic exercise group using the Wilcoxon signed-rank test; #p<0.05,comparisons with VI values in the Taiji group using the Wilcoxon signed-rank test; &p<0.05, significant differences between the Aerobic exercise group versus the Taiji group at V2 using the Wilcoxon rank-sum test. ap<0.05, significant differences in the subscales between the Aerobic exercise group versus the Taiji group at V2 using the Wilcoxon rank-sum test.

Table 2: The constipation-symptom (PAC-SYM) scores after intervention with different exercise patterns in type 2 diabetic patients.

Tai Chi intervention effectively reduced HbA1c and FBG levels, and in both groups, before and after the intervention, there was no significant change in HOMA-IR (Table 3). The B coefficient relationship between PAC-SYM scores and BMI was significant in the aerobic exercise group both before and after adjusting for modeling (Table 4). Changes in biochemical markers (e.g., ALT, TC, TG, HDL, LDL) were insignificant primarily in both groups and may require longer or more rigorous interventions to observe changes (Table 4). After adjusting the model, the B coefficient of eGFR between PAC-SYM scores became significant in the Tai Chi group (P=0.039). In contrast, it was not substantial in the aerobic exercise group (Table 4).

Characteristics	Tai Chi group	t-test	P value	Aerobic exercise group	t-test	P value
HbA1c (%)	Before intervention 8.09 ± 0.65	2.933	0.032	Before intervention 7.93 ± 0.72	1.832	0.538
	After intervention 7.32 ± 0.50			After intervention 7.79 ± 0.88		
C-peptide (ng/ml)	Before intervention 2.93 ± 0.58	3.417	0.735	Before intervention 3.13 ± 0.92	1.254	0.568
	After intervention 3.07 ± 0.69			After intervention 3.03 ± 0.92		
FBG (mmol/l)	Before intervention 8.67 ± 1.23	3.226	0	Before intervention 9.01 ± 1.00	2.368	0.011
	After intervention 6.31 ± 1.58			After intervention 7.78 ± 0.73		
HOMA-IR (mu/l)	Before intervention 1.93 ± 0.47	1.298	0.547	Before intervention 2.16 ± 0.83	1.335	0.673
	After intervention 2.05 ± 0.95			After intervention 2.27 ± 0.87		

Notes: FBG: Fasting Blood Glucose; HbA1C: Glycated Hemoglobin; HOMA-IR: Insulin Resistance.

Table 3: Comparison of biochemical parameters in the two groups before and after intervention.

Variables	Tai Chi group				Aerobic exercise group			
	Unadjusted model		Adjusted model		Unadjusted model		Adjusted model	
	B coeffcient(95% CI)	P	B coeffcient (95% CI)	P	B coeffcient(95% CI)	P	B coeffcient(95% CI)	P
BMI	3.97(-2.89,5.94)	<0.001	2.73(1.66,5.13)	0.031	1.11(-0.87,3.64)	<0.001	1.34(0.55,3.76)	0.043
WC	3.49(1.28,5.31)	0.228	2.99(-1.31,5.11)	0.013	2.58(1.31,4.79)	0.397	0.70(-1.31,2.66)	0.022
C-peptide	1.99(0.73,3.23)	0.492	2.39(0.41,5.19)	0.723	0.49(0.32,2.38)	0.023	1.04(-0.23,4.49)	0.019
FBG	0.23(0.18,1.47)	0.026	0.15(0.09,1.33)	0.013	6.29(3.72,9.21)	0.843	2.97(0.44,4.56)	0.416
HbA1C	-1.82(-2.78,2.99)	0.374	-2.05(-3.11,1.89)	0.427	2.51(1.18,4.15)	0.039	1.36(0.69,4.55)	0.788
HOMA-IR	1.54(1.07-3.11)	0.021	2.37(1.44,5.83)	0.016	0.98(0.15-2.48)	0.014	0.93(0.51,3.31)	0.032
ALT	3.93(-1.11,5.53)	0.662	3.31(1.29,7.21)	0.419	4.65(2.33,6.98)	0.341	3.89(1.66,6.13)	0.873
TC	4.78(-3.52,6.99)	0.691	5.12(-1.96,7.95)	0.705	3.13(1.57,7.71)	0.558	3.35(1.73,4.45)	0.509
TG	3.99(1.27,6.07)	0.592	5.08(3.74,7.83)	0.712	4.06(2.55,6.91)	0.703	2.41(1.03,4.94)	0.512
HDL	4.78(-3.52,6.99)	0.538	3.42(1.08,5.77)	0.664	2.35(0.73,4.72)	0.851	1.39(0.85,3.81)	0.665
LDL	3.56(1.66,5.03)	0.781	4.32(1.23,5.79)	0.794	1.14(0.90,5.04)	0.551	2.89(1.72,3.56)	0.719
eGFR	1.82(0.23,3.94)	0.386	1.02(0.03,2.09)	0.039	0.94(0.11,4.61)	0.783	1.78(0.53,3.18)	0.319

Notes: WC: Waist Circumference; BMI: Body Mass Index; HOMA-IR: Insulin Resistance; Hba1c: Glycated Hemoglobin; FBG: Fasting Blood Glucose; ALT: Alanine Aminotransferase;TC: Total Cholesterol; TG: Triglyceride; LDL: Low Density Lipoprotein; HDL: High Density Lipoprotein; Egfr: Estimated Glomerular Filtration Rate.

Table 4: Linear regression analysis for the association of change of constipation-symptom (PAC-SYM) scores and anthropometric and indicators of glucose metabolism before and after exercise. Model was adjusted for age and gender.

Discussion

In the present study, we could confirm that the Tai Chi group showed significant effects in improving abdominal symptoms (especially bloating) and a variety of bowel symptoms (including feelings of incomplete bowel movements, hardness of bowel movements, small bowel movements, straining, and urgency of bowel movements). The aerobic exercise group also showed some effect in improving painful defecation and incomplete sensation of defecation, but overall, it was less significant than the Tai Chi group. The 24-style Simplified Tai Chi in traditional martial arts, as internal and external training and rigid and flexible boxing art, embody the profound connotation of nourishing the body in tranquility. It is a martial art skill and a way of physical and mental cultivation. It improves the digestive and circulatory system through slow, coherent, rounded, and even movements, as well as respiratory regulation and intentional guidance [22].

Effects of Tai Chi on the digestive system:

1. Promote blood circulation: Tai Chi is a slow aerobic exercise, and the periodic contraction and diastole of the skeletal muscles of the whole body during its practice helps to strengthen blood circulation. This improved blood circulation, especially in the abdominal cavity, can provide more nutrients and oxygen to the digestive organs, thus promoting the digestive organs themselves to be strong and healthy [23,24].
2. The role of abdominal breathing: Tai Chi emphasizes abdominal breathing, which enables the diaphragm to move up and down and provides a good massage for the stomach, liver, intestines, pancreas, and other internal organs. This massage effect can promote blood circulation in the liver and make the digestive glands secrete many digestive juices, thus helping the food be digested more completely [25,26].
3. Improvement of intestinal function: Specific movements in Tai Chi, such as inverted curled arm movement through waist and hip movement with abdominal breathing, can promote peristalsis of the intestines and abdominal muscles and accelerate the discharge of intestinal constipation and toxins, thus helping to improve constipation [27].
4. Tai Chi, as a physical and mental exercise, can improve the mood and mental state of patients with gastrointestinal diseases and constipation [28].

After the intervention, the Tai Chi group significantly reduced HbA1c and FBG levels, indicating that Tai Chi significantly improved glycemic control [29]. The aerobic exercise group also showed some improvement in FBG, but not as significant as the Tai Chi group. There were no significant differences between the two groups in C-peptide and HOMA-IR before and after exercise; these metrics may be less sensitive to intervention compared with HbA1c and FBG.

The significant effect of Tai Chi in improving glycemic control may be related to its promotion of body metabolism, enhancement of insulin sensitivity, and reduction of stress response [30-32]. Aerobic exercise, a common means of diabetes management, has also been found to reduce FBG levels [33], although the effect was not as significant as in the Tai Chi group. This may be because aerobic exercise promotes blood glucose utilization primarily by increasing cardiorespiratory fitness and muscle metabolic rate [33]. In contrast, Tai Chi may work through a more comprehensive mind-body regulatory mechanism [34]. Still, no significant changes were observed in this study, which may indicate that Tai Chi and aerobic exercise have limited direct stimulatory effects on insulin secretion. HOMA-IR is used to assess the degree of insulin resistance, and its lack of significant change may imply that these two exercise modalities, although improving

glycemic control, did not significantly alter insulin sensitivity or insulin resistance status. This may be related to the short duration of the study, the limited sample size, or the intervention modalities' characteristics. Tsang et al. reported that insulin resistance and HbA1c did not significantly improve in patients with T2DM after practicing tai chi for 60 minutes daily [35]. As some of the patients in the study still had unstable glycemic control, different medications, including insulin, were tried during the intervention, which may have contributed to the unpredictability of the results [36].

The study results showed that the effects of different metabolic indicators on PAC-SYM in the Tai Chi and aerobic exercise groups varied in different models. Still, the Tai Chi group showed more significant benefits on PAC-SYM after improving BMI, WC, FBG, and HOMA-IR. C-peptide and HbA1C also significantly affected PAC-SYM in the aerobic exercise group, but the specific effects may vary depending on the adjusting factors. In patients with T2DM, HbA1c $\geq$ 7.0% is the most important risk factor for developing constipation. One study found that the severity of symptoms in T2DM patients was related to the level of HbA1c [37]. High blood glucose disrupts the intestinal barrier, which in turn causes bacteria to spread, leading to inflammation that may spread throughout the intestines and the body and affecting bowel function [38]. Excessive blood glucose fluctuations, either sharp increases or decreases, can disrupt intracellular metabolic pathways. This disruption promotes the production of Reactive Oxygen Species (ROS). Reactive Oxygen Species (ROS) are highly reactive molecules, including superoxide anion, hydrogen peroxide, and hydroxyl radicals, capable of damaging intracellular DNA, proteins, and lipids, thereby triggering cellular damage and dysfunction [39,40]. Prolonged states of hyperglycemia and oxidative stress can damage and apoptosis of gastrointestinal neurons, which can trigger neurodegenerative pathologies. This leads to the weakening of intestinal peristalsis and reduction of secretion, thus triggering gastrointestinal problems such as constipation [41].

These results suggest that individual health status and goals and the specific effects of different exercise modalities on different metabolic markers should be considered when choosing an exercise modality. Through the multiple linear regression analysis of the two groups, we explored the most critical factors influencing the risk of constipation in patients with T2DM. We provided a reference and basis for the early intervention of constipation in patients with T2DM.

Conclusion

Tai chi, as a traditional form of physical exercise, helps improve body shape (reduction in BMI and WC) and regulates blood glucose levels (reduction in FBG). These improvements in metabolic health are critical factors in preventing and managing many chronic diseases (diabetes, cardiovascular disease). The PAC-SYM scale was used to assess symptoms and severity in patients with constipation. The significant reduction of PAC-SYM scores in the tai chi group after improving metabolic indexes suggests that Tai Chi significantly alleviates constipation symptoms. This may be related to Tai Chi enhancing intestinal peristalsis and improving intestinal function in T2DM.

Conflict of Interest: The authors declare no conflict of interest, financial or otherwise.

Human and Animal Rights: No animals were used for the study. All human procedures were followed in accordance with the Helsinki Declaration of 1975 as revised in 2013. All participants signed an informed consent, written consents for this study were obtained from all enrolled patients and the Ethics Committee of Shanghai Yangpu Shidong Hospital approved the study (2024-013-01).

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