Evaluation of the efficacy of Baduanjin in improving glucose and lipid metabolism in patients with prediabetes: a meta-analysis of randomized controlled trials

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Abstract: Objective: The study systematically evaluated the effects of Baduanjin with different time, frequency and cycle on glucose and lipid metabolism in patients with prediabetes of different ages. Methods: Randomized controlled trials (RCTs) on the effect of Baduanjin exercise on PDM patients were comprehensively searched in PubMed, Embase, CNKI and other databases. The retrieval time was from the establishment of the database to September 2022. Results: a total of 13 items of RCT were included in this study, including 415 patients in the trial group and 405 patients in the control group. The results of Meta-analysis showed that FPG (MD-0.45, 95%CI:-0.60, P<0.0l), P < 0.05.The results showed that Baduanjin was superior to the control group in fasting blood glucose in patients with prediabetes, and TG (MD=-0.29,95%CI:-0.52 Baduanjin was better than the control group in improving triglyceride (TG). HDL-C (MD=0.06,95%CI:0.02~0.11,P < 0.01), P < 0.05.Results showed that the intervention group of Baduanjin was superior to the control group in improving high density lipoprotein cholesterol (HDL-C) in patients with prediabetes. LDL-C (MD=-0.27,95% CI:-0.44~-0.10,P=0.002), P < 0.05.The results showed that the intervention group of Baduanjin was superior to the control group in improving low density lipoprotein cholesterol (LDL-C) in prediabetic patients. The results of TC (MD=--0.36,95%CI:-0.60~-0.12,P=0.004 < 0.05) showed that the intervention group was superior to the control group in improving serum total cholesterol (TC) in patients with prediabetes. The results of subgroup analysis showed that when the age of the patients<60 years old, the intervention time ≥ 60 minutes, the intervention period ≥ 6 months and the intervention frequency ≥ 5 days, the Baduanjin was superior to the control group in improving the indexes of prediabetes. Conclusion: Baduanjin can further improve the level of glucose and lipid metabolism in patients with prediabetes, especially in FPG, TC, HDL-C and LDL-C.

Keywords: prediabetes; Baduanjin; glucose and lipid metabolism; systematic review; Meta-analysis

1. Introduction

Prediabetes (Prediabetesmellitus, PDM) refers to the transitional state of individual blood glucose concentration higher than normal but lower than the threshold of diabetes [1], including impaired fasting glucose (IFG), impaired glucose tolerance (Impaired glucosetolerance, IGT) and both mixed state. Prediabetes is a high-risk stage for progression to diabetes [2]. National epidemiological surveys show that the incidence of prediabetes in my country is 35.2% [3]. If the diagnosis of prediabetes is not timely intervened, about 7.7%-9.0%[4] of prediabetic patients will progress to diabetes every year, seriously affecting the quality of life of individuals. Exercise therapy has a significant effect on blood sugar control in diabetic patients. "Guidelines for the Prevention and Treatment of Type 2 Diabetes in China (2020 Edition)" [5] pointed out that people with pre-diabetes can prevent the occurrence of diabetes through proper exercise. The World Health Organization (WHO) recommends moderate-intensity aerobic exercise as the best form of exercise for IGR patients, and exercise is an important part of prediabetes management. Baduanjin is a unique traditional Chinese medicine health-preserving exercise in my country. It integrates "regulating the body, breath, and heart". To achieve the movement of qi along with

the force, flow into the meridians of the body, so that qi and blood can flow smoothly along the meridians, so as to improve body shape, regulate blood sugar, regulate negative emotions, and improve cognitive functions. Studies have shown that Baduanjin has positive effects on people with diabetes, but there is no consensus on its effectiveness and safety for people with prediabetes. Therefore, this study used a systematic review method to evaluate the impact of Baduanjin on pre-diabetic populations, aiming to provide a reference for the clinical application of Baduanjin.

2. Data and methods

2.1 Inclusion and exclusion criteria

2.1.1 Inclusion criteria

① Research type: Randomized Controlled Trials(RCT); ② Research object: prediabetes; ③ Intervention measures: The control group was treated with routine treatment, including lifestyle intervention, health education or guidance, routine life and so on. The experimental group was combined with Baduanjin on the basis of the control group.④Outcome index: Fasting plasma glucose (FPG), 2-hour postprandial glucose (2hPG); High-density lipoprotein-cholesterol (HDL-C), Total cholesterol (TC), Triglycerides(TG), Low-density lipoprotein-cholesterol(LDL-C);

2.1.2 Exclusion criteria

①Repeatedly published research literature; ②Non-clinical randomized controlled trials, such as reviews, case reports, etc; ③The full text cannot be obtained or the outcome indicator data is incomplete;

2.2 Literature search, screening and quality evaluation

We searched PubMed, Embase, CochraneLibrary, CBM, CNKI, WanFang and VIP databases to collect RCTS of Baduanjin intervention in patients with prediabetes. The retrieval time was from the establishment of the database to September 2022.Chinese search words included Baduanjin, fitness Qigong, exercise therapy, traditional Chinese skills, traditional Chinese sports, pre-diabetes, reduced glucose tolerance, impaired glucose tolerance, impaired glucose regulation, impaired fasting blood glucose, low glucose tolerance, etc.Literature screening is carried out first, and then the title, abstract and full text are read for screening.The contents of the data include: ① the basic information of the included literature: title, first author, publication time;② Basic characteristics of the subjects: average age, sample size;③ Intervention measures: specific intervention measures and cycle;④ Outcome indicators.The risk of literature bias in the included studies was assessed using the Cochrane Manual 5.1.0 recommended RCT bias risk assessment tool.If you have a disagreement, discuss it.

3. Meta-analysis results

463 studies were collected, and finally 13 studies were included in Meta-analysis. Meta-analysis was carried out by using Revman5.4.1 software, and 95% (confidenceinterval,CI) was given for each effect index. I^2 was used to quantitatively evaluate the heterogeneity. If $I^2<50\%$, the fix-effectmodel is used for Meta-analysis; if $I^2\geq50\%$, the random-effectmodel is used for Meta-analysis.

3.1 Effect of Baduanjinon FPG in patients with PDM

The effect of Baduanjin on FPG in patients with prediabetes was reported, including 820 patients with PDM. The heterogeneity among the studies was relatively large ($I^2= 88\%$, P < 0.0001). The random effect model was used to analyze the results. The results showed that the Baduanjin was superior to the control group in fasting blood glucose in patients with prediabetes (MD-0.45,95% CI:-0.60~-0.29, P < 0.01).Due to the large heterogeneity, the results were stable and did not change obviously after being eliminated one by one. In order to explore the source of heterogeneity among studies, a subgroup analysis of the included literature was conducted (Table 1). The results of subgroup analysis showed that there was no significant statistical difference among different frequency, different exercise time and cycle groups, the intervention group was better than the control group, and the intervention effect was poor in the group older than 60. The reason for the high heterogeneity may also be related to the uneven quality and bias of the included studies.

Table 1 Subgroup Analysis of FPG

Project	Group	Number	MD	95%CI	P	I^2
Age	40-50	3	-0.46	(-0.64, -0.28)	<0.001	61%
	50-60	7	-0.41	(-0.62, -0.20)	<0.001	92%
	>60	3	-0.69	(-1.52, 0.14)	0.10	90%
	Total	13	-0.45	(-0.60, -0.29)	<0.001	88%
Intervention time(min/d)	30-60	9	-0.48	(-0.67, -0.28)	<0.001	90%
	≥60	4	-0.37	(-0.55, -0.20)	<0.001	67%
	Total	13	-0.45	(-0.60, -0.29)	<0.001	88%
Intervention cycle(Month)	<6	4	-0.26	(-0.42, -0.09)	0.002	57%
	≥6	9	-0.54	(-0.72, -0.35)	<0.001	88%
	Total	13	-0.45	(-0.60, -0.29)	<0.001	88%
Intervention frequency(Day / week)	<5	4	-0.44	(-0.72, -0.17)	0.002	93%
	≥5	9	-0.42	(-0.56, -0.28)	<0.001	70%
	Total	13	-0.45	(-0.60, -0.29)	<0.001	88%

3.2 Effect of Baduanjin on TG in patients with PDM

Eight literatures reported the effect of Baduanjin on TG in patients with prediabetes, including 497 patients with PDM. The heterogeneity among the studies was large (I^2=98%, P<0.001). The random effect model was used for analysis. The results showed that the Baduanjin intervention group was superior to the control group in improving TG. (MD=-0.29, 95%CI:-0.52~-0.07,P=0.01). The results of subgroup analysis showed that when the age < 50 years old, the intervention time > 30 minutes, the intervention period≥6 months and the intervention frequency≥5 days, the effect of Baduanjin on triglyceride in patients with prediabetes was better than that in the control group (Table 2).

Table 2 Subgroup Analysis of TG

Project	Group	Number	MD	95%CI	P	I2
Age	40-50	3	-0.30	(-0.53, -0.07)	0.01	65
	50-60	4	-0.34	(-0.78, 0.10)	0.13	94%
	> 60	1	-0.08	(-0.32, 0.48)	-	-
	Total	8	-0.29	(-0.52, -0.07)	0.01	89%
Intervention time(min/d)	30-60	4	-0.49	(-0.92, -0.06)	0.03	87%
	≥60	4	-0.11	(-0.20, -0.01)	0.03	21%
	Total	8	-0.29	(-0.52, -0.07)	0.01	89%
Intervention cycle(Month)	< 6	4	-0.13	(-0.28, 0.02)	0.09	58%
	≥6	4	-0.47	(-0.91, -0.03)	0.04	91%
	Total	8	-0.29	(-0.52, -0.07)	0.01	89%
Intervention frequency(Day / week)	< 5	2	-0.30	(-1.05, 0.44)	0.43	86%
	≥5	6	-0.29	(-0.55, -0.04)	0.02	91%
	Total	8	-0.29	(-0.52, -0.07)	0.01	89%

3.3 Effect of Baduanjin on HDL-C in patients with PDM

Eight literatures reported the effect of Baduanjin on HDL-C in patients with prediabetes, including 497 patients with PDM. The heterogeneity among the studies was small (I^2=35%, P=0.15). The fixed effect model was used to analyze the results. The results did not show that the intervention group was superior to the control group in improving high density lipoprotein cholesterol in patients with prediabetes (MD=0.06,95% CI:0.02~0.11, P < 0.01).

3.4 Effect of Baduanjin on LDL-C in patients with PDM

Eight articles reported the effect of Baduanjin on LDL-C in prediabetic patients, including 497 patients with PDM.There was a large heterogeneity among the studies (I^2=78%, P=0.15), and the random-effects model was used to analyze the results. The results showed that the eight-stage Qigang intervention

group was better than the control group in improving LDL-C in prediabetic patients (MD=-0.27,95%CI:-0.44 ~ -0.10,P=0.002).The results of subgroup analysis showed that the effect of Baduanjin on low density lipoprotein cholesterol in prediabetic patients was better than that in the control group when the age was less than 60 years old, intervention time ≥60 minutes, intervention period ≥6 months, intervention frequency ≥5 days(Table 3).

Table 3 Subgroup Analysis of LDL-C

Project	Group	Number	MD	95%CI	P	I2
Age	40-50	3	-0.39	(-0.56, -0.22)	< 0.001	51%
	50-60	4	-0.27	(-0.52, -0.01)	0.04	78%
	> 60	1	-0.10	(-0.24, 0.44)	-	-
	Total	8	-0.27	(-0.44, -0.10)	0.002	78%
Intervention time(min/d)	30-60	4	-0.31	(-0.68, 0.06)	0.1	87%
	≥60	4	-0.24	(-0.36, -0.12)	< 0.001	29%
	Total	8	-0.29	(-0.44, -0.10)	0.002	78%
Intervention cycle(Month)	< 6	4	-0.16	(-0.38, 0.06)	0.16	73%
	≥6	4	-0.38	(-0.62, -0.14)	0.002	77%
	Total	8	-0.27	(-0.44, -0.10)	0.002	78%
Intervention frequency(Day / week)	< 5	2	-0.21	(-0.96, 0.55)	0.59	94%
	≥5	6	-0.30	(-0.45, -0.14)	< 0.001	66%
	Total	8	-0.27	(-0.44, -0.10)	0.002	78%

3.5 Effect of Baduanjin on TC in patients with PDM

The effect of Baduanjin on TC in patients with prediabetes was reported in 8 literatures, including 497 patients with PDM. The heterogeneity among the studies was large (I^2=82%, P<0.001). The random effect model was used for analysis. The results showed that the Baduanjin intervention group was superior to the control group in improving TC in prediabetic patients (MD=-0.36, 95%CI:-0.60~-0.12,P=0.004). The results of subgroup analysis showed that when the age < 60 years old, the intervention time≥60 minutes, the intervention period≥6 months, and the intervention frequency≥5 days, the effect of Baduanjin on serum total cholesterol in patients with prediabetes was better than that in the control group(Table 4).

Table 4 Subgroup Analysis of TC

Project	Group	Number	MD	95%CI	P	I^2
Age	40-50	3	-0.51	(-0.87, -0.15)	0.005	80%
	50-60	4	-0.38	(-0.73, -0.03)	0.03	79%
	＞60	1	-0.32	(-0.13, 0.77)	-	-
	Total	8	-0.36	(-0.60, -0.12)	0.004	82%
Intervention time(min/d)	30-60	4	-0.50	(-1.01, 0.00)	0.05	85%
	≥60	4	-0.19	(-0.29, -0.08)	＜0.001	0%
	Total	8	-0.36	(-0.60, -0.12)	0.004	82%
Intervention cycle(Month)	＜6	4	-0.18	(-0.46, 0.09)	0.19	69%
	≥6	4	-0.52	(-0.85, -0.19)	0.002	76%
	Total	8	-0.36	(-0.60, -0.12)	0.004	82%
Intervention frequency(Day / week)	＜5	2	-0.30	(-1.50, 0.89)	0.62	95%
	≥5	6	-0.34	(-0.55, -0.14)	＜0.001	66%
	Total	8	-0.36	(-0.60, -0.12)	0.004	82%

4. Discussion

The results of Meta-analysis showed that the improvement of various indexes in patients with prediabetes by Baduanjin was better than that in the control group. The results of subgroup analysis showed that when the age of the patients was less than 60 years old, the intervention time was more than

60 minutes, the intervention period was more than 6 months and the intervention frequency was more than 5 days, the Baduanjin was superior to the control group in improving the indexes of prediabetes.

Baduanjin is a traditional exercise in my country. It is a moderate-intensity exercise. It is a low-to-medium-intensity aerobic exercise with good safety. Through long-term and uninterrupted practice of Baduanjin, it can promote the smooth flow of Qi and blood in the body, balance yin and yang, effectively control the body mass index of pre-diabetic patients, regulate the blood sugar and glycosylated hemoglobin of patients, so as to effectively regulate the psychological state of pre-diabetic patients the goal of [6].The scientific mechanism is: exercise can effectively increase energy consumption, reduce the burden of lipid on skeletal muscle cells, pancreatic cells and liver cells, thereby enhancing the ability of skeletal muscle cells to absorb glucose and pancreatic cells to secrete insulin[7];Cause changes in the quality and quantity of insulin receptors, enhance the ability of skeletal muscle cells to absorb glucose; improve the activity of skeletal muscle cell mitochondrial electronic respiratory chain complex enzymes, and improve the ability of skeletal muscle cell mitochondria to do work[8]. "Guidelines for the Prevention and Treatment of Type 2 Diabetes in China" recommends that people with prediabetes should adhere to aerobic exercise and resistance exercise, and recommends exercise time and exercise intensity, but does not propose specific exercise prescriptions. [5] This paper conducts in-depth research on this point, through literature research, combined with existing evidence-based medical evidence, to evaluate the effect of Baduanjin on glucose and lipid metabolism in pre-diabetic patients, and to explore exercise prescriptions for reference.

Acknowledgement

References

[1] Endocrinology Society of Chinese Medical Association, Diabetes Society of Chinese Medical Association. Expert consensus on prediabetes intervention in Chinese adults [J]. Chinese Journal of Endocrinology and Metabolism, 2020, 36(5):371-380.

[2] Xijuan Luo. The effect of aerobic and resistance exercise on glucose regulation in pre-diabetes population and its mechanism [D]. Beijing: Beijing Sport University, 2016.

[3] Li Y, Teng D, Shi X, et al. Prevalence of diabetes recorded in mainland China using 2018 diagnostic criteria from the American Diabetes Association: national cross-sectional study[J].BMJ,2020, 369(4):m997.

[4] American Diabetes Association. Lifestyle management: standards of medical care in diabetes 2019 [J]. Diabetes Care, 2019, 42(Suppl1):S46-60.

[5] Chinese Medical Association Diabetes Branch. Guidelines for Prevention and Treatment of Type 2 Diabetes in China (2020 Edition) [J]. Chinese Journal of Diabetes, 2021, 13(4):317-411.

[6] Ren Jianqing, Wu Yunchuan. Analysis of the status quo of prediabetes intervention. Shanghai Journal of Traditional Chinese Medicine. 2014. 48(03):87-88.

[7] Wang Congrong, Liu Yabing, Wang Jingze, Yao Wenzhen, Yang Xirang. Effects of dietary fat content and endurance exercise on insulin receptor tyrosine protein kinase in obese mice. Sports Science. 2000. (06): 51-54.

[8] Guo Yanqing, Zhang Min, Zhao Xiaoli, etc. Effects of different exercise modes and time on the activity of enzymes I and IV of the mitochondrial respiratory chain complex in rat skeletal muscle. Chinese Tissue Engineering Research and Clinical Rehabilitation. 2011.15(02): 317-320.