The Effects of Tai Chi and Walking on Fasting Blood Glucose among Patients with Type II Diabetes Mellitus

Forough Rafii, Daryadokht Masroor¹, Hamid Haghani², Hamideh Azimi³

Department of Medical Surgical Nursing, Nursing Care Research Center, School of Nursing and Midwifery, Iran University of Medical Sciences, ¹Department of Medical Surgical Nursing, School of Nursing and Midwifery, Iran University of Medical Science, ²Department of Biostatistics, School of Public Health, Iran University of Medical Sciences, Tehran, Iran

Abstract

**Background:** Effective diabetes mellitus (DM) prevention and management necessitate blood glucose monitoring, health education, and professional nursing care. **Objectives:** The aim of this study was to compare the effects of Tai Chi and walking on fasting blood glucose (FBG) among patients with type II DM. **Methods:** In this randomized controlled trial study, 100 patients with type II DM were randomly allocated to a Tai Chi, a walking, and a control group. Patients in the control group performed no regular physical exercise. However, patients in the Tai Chi and the walking groups, respectively, did Tai Chi and walking in three 30-min sessions a week for eight successive weeks. FBG was assessed before and after the interventions. The data were analyzed through the one-way analysis of variance paired-sample t, and Scheffe’s tests. **Results:** Posttest values of FBG in the Tai Chi and the walking groups were significantly lower than the corresponding pretest values (P = 0.013 and 0.004, respectively). Moreover, after the intervention, FBG level in the control group was significantly higher than the Tai Chi (P < 0.001) and the walking (P < 0.0001) groups while the difference between the Tai Chi and the walking groups was not statistically significant (P = 0.571). **Conclusion:** Eight-week Tia Chi and walking are effective in lowering blood glucose among patients with type II DM. These exercises are recommended for patients with type II DM.

**Keywords:** Diabetes mellitus, Exercise, Tai Chi, Walking

Introduction

Diabetes mellitus (DM) is a major health challenge worldwide.[¹] The most common type of DM is type II DM, constituting around 90% of all types of DM.[²] The global prevalence of type II DM in 2010 was 6.4%, and it is estimated to reach 7.7% by 2030. In 2009, its prevalence in Asia and the Middle East increased by 12% and 36%, respectively.[³,⁴] The prevalence of type II DM in Iran is also 4%–5.4% in the general population and around 14% among Iranians above thirty.[⁵]

The key components of effective DM prevention and management are blood glucose monitoring, health education, and professional nursing care.[¹,⁶] Nurses can significantly contribute to the improvement of diabetic patients’ physical and mental health through enhancing their self-care abilities, using attractive patient education methods,[²] and encouraging them to engage in physical exercise.[⁸] Exercise promotes epinephrine release, reduces insulin uptake, and thereby lowers blood glucose.[⁹]

One type of exercise is Tai Chi. It is a set of slow and harmonious movements of different parts of the body accompanied by deep breathing.[⁹] Unlike other types of physical exercise, Tai Chi includes different types of relaxation techniques such as stress reduction, replacement of negative thoughts with positives, and muscle relaxation.[¹⁰] Tai Chi helps achieve and improve physical health and mind-body balance.[⁹] Moreover, it improves muscular flexibility, strengthens internal body

Address for correspondence: Ms. Hamideh Azimi, Department of Medical Surgical Nursing, School of Nursing and Midwifery, Iran University of Medical Science, Yasemi Street, Tehran, Iran. E-mail: h.azimi88@yahoo.com

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

How to cite this article: Rafii F, Masroor D, Haghani H, Azimi H. The effects of Tai Chi and walking on fasting blood glucose among patients with type II diabetes mellitus. Nurs Midwifery Stud 2018;7:56-61.
structures, promotes breathing, affects the pancreas, reduces body fat percentage, increases cellular sensitivity to insulin, reduces insulin resistance\textsuperscript{[11]} and improves the insulin receptor function.\textsuperscript{[6]}

A study showed that Tai Chi was as effective as aerobic exercise in reducing blood glucose.\textsuperscript{[12]} However, despite the availability of rational reasons for the effectiveness of Tai Chi in increasing cellular sensitivity to insulin, some studies reported that it had no significant effects on blood glucose.\textsuperscript{[10,13,14]}

Walking is the exercise of choice for diabetic patients.\textsuperscript{[15]} However, it may increase the risk for diabetic foot syndrome.\textsuperscript{[16]} There are limited comparative studies into the effects of walking and Tai Chi as well as conventional and modern Tai Chi styles.

Objectives
The aim of this study was to compare the effects of Tai Chi and walking on fasting blood glucose (FBG) among patients with type II DM.

METHODS
Study design and participants
This randomized controlled trial study was carried out in the clinics of Rasoul Akram (PBUH) and Firouzgar hospitals, Tehran, Iran.

The sample size was determined based on the assumption that both walking and Tai Chi interventions significantly affect the FBG of patients with type II DM.\textsuperscript{[17]} Therefore, considering a power of 80%, a significance level of 0.05, a \( d \) of 13.5, and an FBG standard deviation of 19.5,\textsuperscript{[17]} sample size for each study group was determined to be 32 [Figure 1]. Nevertheless, given the likelihood of patient withdrawal from the study, the sample size was increased by 15% to 37.

The fourth author referred to the study setting and recruited a convenience sample of eligible patients. Eligibility criteria included an age of 20–60, a definitive diagnosis of type II DM established by a treating physician, the use of metformin or glibenclamide, no limitation in doing physical exercise, and no history of musculoskeletal, cardiovascular, or respiratory problems. Patients who took insulin, were hospitalized, did not tolerate physical exercise, were unable to regularly attend physical exercise sessions, and developed foot problems during the study were excluded.

Blocking method had been considered to allocate patients into a Tai Chi, a walking, and a control group. The size of each block was three. Accordingly, three similar envelopes, containing the assumed names of the groups, were placed on a table with different permutations and each three participants were asked to randomly select an envelope.

Intervention
Patients in the control group performed no regular physical exercise. However, their counterparts in the Tai Chi and the walking groups, respectively, did Tai Chi and walking in male and female subgroups in three 30-min sessions a week for 8 successive weeks. Both interventions were implemented 1–2 h after a light breakfast to prevent blood glucose decrease during the interventions. In each session, patients in the walking group walked an almost 2-km distance in 30 min. They were asked to immediately inform the fourth researcher in the case of any severe unbearable palpitation. In such cases, their heart rate (HR) was measured and if it was 60%–70% of their baseline HR, they were asked to take a break. Once the HR returned to its baseline value, they were asked to continue walking. On the other side, patients in the Tai Chi group were trained to perform selective movements of the traditional 18-movement Chen style\textsuperscript{[19]} and the modern 24-movement Yang style\textsuperscript{[16]} Tai Chi under the supervision of a male or a female Tai Chi trainer. In other words, they watched the trainer performing the movements and simultaneously performed them. For each session, the trainer selected several traditional and or modern Tai Chi movements, performed them, and trained participants to perform them. Each Tai Chi session consisted of a 5-min warm-up (stretching exercises), a 20-min Tai Chi, and a 5-min cool-down. All walking and Tai Chi sessions were supervised and managed by the fourth-researcher and a trainer. The fourth researcher monitored patients for symptoms such as tachycardia, perspiration, and severe weakness. Each patient who experienced these symptoms was immediately transferred to the nearest hospital setting.

Instruments
At the beginning of the study, a questionnaire was used to collect data on patients’ age, gender, educational and marital status, HR, systolic and diastolic blood pressures (SBP and DBP), body mass index (BMI), and medication use. Moreover, for FBG assessment, a blood sample was drawn from each patient after a fasting period of 6–8 h both at the beginning and at the end of the study intervention.
**Ethical considerations**

The study was registered in the Iranian Registry of Clinical Trials (IRCT201511197101N3) and approved by the Ethics Committee of Iran University of Medical Sciences, Tehran, Iran (IR.IUMS.REC.1394.9311686019). At the beginning of the study, participants were informed about the aim, advantages, and probable disadvantages of the study and signed a written informed consent. They were assured that their data would remain confidential and would be used only for the purposes of the present study. Moreover, they had the absolute right to withdraw from the study whenever they preferred.

**Data analysis**

The SPSS software v. 16.0 (SPSS Inc., Chicago, IL, USA) was employed for data management and analysis. The Kolmogorov–Smirnov and the Levene’s tests were done for normality testing and variance equality assessment, respectively. The groups were compared respecting patients’ age, SBP, DBP, BMI, and FBG through the one-way analysis of variance and the Scheffe test. Moreover, between-group comparisons regarding patients’ gender, educational status, and the type of anti-diabetic medications were done using the Chi-square tests. The paired-sample t-test was also applied for within-group comparisons. The data were presented in relative frequency, mean, and standard deviation and the level of significance was set at <0.05.

**RESULTS**

During the first three and the last 2 weeks of the intervention, four patients from the Tai Chi group were excluded due to fatigue. Moreover, four patients from the walking group were excluded in the first 5 weeks of the intervention due to hospitalization or a traffic accident. Similarly, three patients were excluded from the control group because they did not refer to the study setting for posttest FBG assessment [Figure 2].

There were no significant differences among the groups respecting patients’ demographic characteristics [Table 1]. Within-group comparisons revealed that posttest values of FBG in the Tai Chi and the walking groups were significantly lower than the corresponding pretest values ($P = 0.013$ and 0.004, respectively). However, pretest-posttest changes of FBG in the control group were not statistically significant [$P > 0.05$; Table 2].

The one-way analysis of variance test indicated that at baseline, the groups did not differ significantly from each other respecting FBG ($P > 0.05$). However, a significant difference among the groups was observed respecting posttest values of FBG ($P < 0.0001$). The

---

**Figure 2:** The study flow diagram

- **Assessed for eligibility** ($n = 154$)
  - Excluded ($n = 43$)
    - Not meeting inclusion criteria ($n = 15$)
    - Declined to participate ($n = 20$)
    - Other reasons ($n = 8$)
- **Randomized** ($n = 111$)
- **Allocated to walking group** ($n = 37$)
  - Excluded (due to: hospitalization or a traffic accident) ($n = 4$)
  - Analyze ($n = 33$)
- **Allocated to Tai Chi group** ($n = 37$)
  - Excluded (due to: fatigue) ($n = 4$)
  - Analyze ($n = 33$)
- **Allocated to the control group** ($n = 37$)
  - Excluded (due to: not referring for posttest FBG assessment) ($n = 3$)
  - Analyze ($n = 34$)
Table 1: Comparing the groups respecting participant’s demographic characteristics

| Variable          | Tai Chi (n=33) | Walking (n=33) | Control (n=34) | P  |
|-------------------|----------------|---------------|----------------|----|
| Age               | 51.63 ± 6.35   | 53.18 ± 4.99  | 51.85 ± 7.83   | 0.581 |
| Mean SBP          | 125.45 ± 13.19 | 120.76 ± 14.20 | 128.38 ± 17.86 | 0.125 |
| Mean DBP          | 82.42 ± 9.69   | 76.96 ± 9.99  | 80.58 ± 10.42  | 0.086 |
| BMI               | 28.73 ± 3.25   | 28.28 ± 2.40  | 28.75 ± 2.47   | 0.737 |
| Gender            |                |               |                |    |
| Female            | 20 (61)        | 18 (55)       | 20 (59)        | 0.877 |
| Male              | 13 (39)        | 15 (45)       | 14 (41)        |    |
| Education         |                |               |                |    |
| Less than diploma | 8 (24.3)       | 12 (36.4)     | 11 (32.4)      | 0.076 |
| Diploma           | 21 (63.6)      | 10 (30.3)     | 11 (32.4)      |    |
| Higher education  | 4 (12.1)       | 11 (33.3)     | 12 (35.2)      |    |
| Drugs used        |                |               |                |    |
| Metformin         | 20 (60.6)      | 9 (27.3)      | 13 (38.2)      | 0.053 |
| Glibenclamid      | 6 (18.2)       | 8 (24.2)      | 5 (14.7)       |    |
| Both              | 7 (21.2)       | 16 (48.5)     | 16 (47.1)      |    |

*Values are expressed as n (%) or mean ± SD, *Analysis of variance was performed for age, systolic and diastolic blood pressures, and body mass index while Chi-square test was performed for other variables. SBP: Systolic blood pressure, DBP: Diastolic blood pressure, SD: Standard deviation, BMI: Body mass index

Table 2: The mean values of fasting blood glucose in three groups both before and after the intervention

| FBG          | Mean ± SD   | P    |
|--------------|-------------|------|
| Tai Chi      |             |      |
| Pretest      | 149.82 ± 36.13 | 0.013 |
| Posttest     | 124.21 ± 29.92 |      |
| Walking      |             |      |
| Pretest      | 134.12 ± 44.69 | 0.004 |
| Posttest     | 118.03 ± 18.50 |      |
| Control      |             |      |
| Pretest      | 135.47 ± 24.54 | 0.055 |
| Posttest     | 152.59 ± 43.62 |      |
| Total groups |             |      |
| Pretest      | 152.21 ± 43.62 | 0.150 |
| Posttest     | >0.0001     |      |

SD: Standard deviation, FBG: Fasting blood glucose

Schefte’s test revealed that after the intervention, FBG level in the control group was significantly higher than the Tai Chi (P = 0.001) and the walking (P < 0.0001) groups while the difference between the Tai Chi and walking group was not statistically significant [P = 0.571; Table 3].

**DISCUSSION**

The study findings revealed the effectiveness of the 8-week Tai Chi program in decreasing the level of FBG. Lee et al. and Chang et al. also reported the same finding.[18,19] However, our finding contradicted the findings reported in other studies.[10,13,14] Previous studies attributed decreases in FBG following Tai Chi to factors such as age, BMI, as well as the intensity and the type of Tai Chi exercises. Shen et al. also used the simplified 24-movement Yang style Tai Chi and found no significant decrease in FBG.[10] Some other studies also reported the same finding for the simplified 24-movement Yang style Tai Chi. Given the contradictory results of previous studies respecting the effectiveness of the 24-movement Yang style Tai Chi, we predicted the probability of the ineffectiveness of this style and hence, selected movements from both the traditional 18-item Chen style and the modern 24-movement Yang style Tai Chi. Combination of these two styles in the present study might be the reason behind the contradiction between Shen et al.’ and our findings. Besides, the mean of BMI in the present study was lower than that of the Shen et al.’ Probably, Yang Tai Chi is more effective among people with a BMI of <30. Studies also showed that higher body fat percentage reduces insulin sensitivity, increases insulin resistance,[11] and impairs the function of insulin receptors.[6]

Contrary to our findings, Tsang et al. also reported the insignificant effects of a specific type of Tai Chi, i.e. Tai Chi for Diabetes, on blood glucose. They attributed the ineffectiveness of their intervention in lowering blood glucose to its inadequacy for lowering glycosylated hemoglobin and insulin resistance.[13] A strength of the present study was the combination of the 18-movement Chen and the simplified 24-movement Yang Tai Chi which might have boosted the effectiveness of Tai Chi exercise in reducing FBG.

Another finding of the present study was a significant decrease in FBG following the 8-week walking intervention. Valizadeh et al. and Parsian et al. also
found significant decreases in blood glucose after several weeks of aerobic exercise.\cite{20,21} Aerobic exercise promotes circulation, increases the function of glycogen synthase, facilitates glucose uptake by muscle tissue,\cite{22} and thereby reduces blood glucose.\cite{23} On the other hand, given the direct relationship of insulin resistance with muscle mass, aerobic exercise can reduce insulin resistance by activating lipoprotein lipase and promoting fat oxidation.\cite{22} Despite the known effectiveness of aerobic exercise in reducing blood glucose, Sardar et al.\cite{24} and Bello et al.\cite{25} reported that their several-week aerobic exercise interventions had no significant effects on blood glucose.\cite{24,25} The contradiction of their findings with the findings of the present study may be because Sardar et al. performed their study on patients with type I DM and Bello et al. used a mild-intensity exercise program; however, our walking intervention was a moderate-intensity exercise and was implemented for patients with type II DM. Studies show that the effectiveness of aerobic exercise greatly depends on its intensity and patients’ underlying conditions.\cite{24‑26} It is noteworthy that exercise improves tissue response to insulin. However, type I DM is due to the lack of insulin production, and hence, exercise cannot reduce blood glucose among patients with this type of DM.\cite{21}

Table 3: The pre- and post-test mean difference of fasting blood glucose in three groups

| Variable | Tai Chi | Walking | Control |
|----------|---------|---------|---------|
| FBG      | 25.60 ± 30.29 | 16.09 ± 41.13 | 17.11 ± 37.00 |

\*Values are expressed as mean difference ± SD. SD: Standard deviation, FBG: Fasting blood glucose

**CONCLUSION**

This study shows that the 8-week Tai Chi has positive effects on FBG. However, it has no advantage over walking. In other words, the effects of Tai Chi are almost the same as the effects of walking. In Tai Chi, all joints of the body are used and moved. Moreover, Tai Chi includes different types of relaxation techniques. Therefore, it can significantly lower FBG and alleviate stress and can be used for diabetic patients either alone or in combination with walking.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

**REFERENCES**

1. Borhani F, Ranjbar H, Abbaszadeh A, Abazari F, Ranjbar A. The effect of tele-nursing (cellphone software) on A1c, hemoglobin in patients with type 2 diabetes mellitus. J Arm Univ Med Sic 2013;11:130‑7.
2. Hu FB. Globalization of diabetes: The role of diet, lifestyle, and genes. Diabetes Care 2011;34:1249‑57.
3. Shaw JE, Sirie RA, Zimet PZ. Global estimates of the prevalence of diabetes for 2010 and 2030. Diabetes Res Clin Pract 2010;87:4‑14.
4. Sharma M, Knowlden AP. Role of yoga in preventing and controlling type 2 diabetes mellitus. J Evid Based Complementary Altern Med 2012;17:88‑95.
5. Baghianimoghadam MH, Afkhami, Ardekani M, Baghianimoghadam B. Effect of education on improvement of quality of life by SF-20 in type 2 diabetic patients. Acta Med Indones 2009;41:175‑80.
6. Fetherston CM, Wei L. The benefits of Tai Chi as a self‑management strategy to improve health in people with chronic conditions. J Nurs Healc Chronic Illn 2011;3:155‑64.
7. Heidari H, Mardani Hamooleh M. Improving communication skills in clinical education of nursing students. Client Cent Nurs Care 2015;1:77‑82.
8. American Diabetes Association. Standards of medical care in diabetes-2013. Diabetes Care 2013;36 Suppl 1:S11‑66.
9. Jahnke R, Larkey L, Rogers C, Etnier J, Lin F. A comprehensive review of health benefits of qigong and Tai Chi. Am J Health Promot 2010;24:e1‑25.
10. Shen CL, Feng D, Esperat CR, Irons B, Chyu M, Valdez G, et al. Effect of Tai Chi exercise on type 2 diabetes: A feasibility study. Integr Med Insights 2007;2:15‑23.
11. Yeh SH, Chuang H, Lin LW, Hsiao CY, Wang PW, Yang KD, et al. Tai Chi chuan exercise decreases A1C levels along with increase of regulatory T‑cells and decrease of cytotoxic T‑cell population in type 2 diabetic patients. Diabetes Care 2007;30:716‑8.
12. Wang P, Han QY, Li GT, Liang RR. Evaluation of varying aerobic interventions on type 2 diabetes patients in community. China Med Her 2009;6:34‑5.
13. Tsang T, Orr R, Lam P, Comino E, Singh MF. Effects of Tai Chi on glucose homeostasis and insulin sensitivity in older adults with type 2 diabetes: A randomised double-blind sham‑exercise‑controlled trial. Age Ageing 2008;37:64‑71.
14. Chen SC, Ueng KC, Lee SH, Sun KT, Lee MC. Effect of T’ai Chi exercise on biochemical profiles and oxidative stress indicators in obese patients with type 2 diabetes. J Altern Complement Med 2010;16:1153‑9.
15. Hancock C, C3 Collaborating for Health. Review the Benefits of Regular Walking for Health, Well – Being and the Environment; 2012. p. 31. Available from: https://www.c3health.org/wp-content/uploads/2017/07/C3-report-on-walking-v-1-20120911.pdf. [Last accessed on 2012 Sep].
Rafii, et al.: Effects of Tai Chi and walking on fasting blood glucose

16. Barshes NR, Sigireddi M, Wrobel JS, Mahankali A, Robbins JM, Kougias P, et al. The system of care for the diabetic foot: Objectives, outcomes, and opportunities. Diabet Foot Ankle 2013;4:1-12.

17. Karstoft K, Winding K, Knudsen SH, Nielsen JS, Thomsen C, Pedersen BK, et al. The effects of free-living interval-walking training on glycemic control, body composition, and physical fitness in type 2 diabetic patients: A randomized, controlled trial. Diabetes Care 2013;36:228-36.

18. Lee MS, Jun JH, Lim HJ, Lim HS. A systematic review and meta-analysis of Tai Chi for treating type 2 diabetes. Maturitas 2015;80:14-23.

19. Chang RY, Koo M, Chen CK, Lu YC, Lin YF. Effects of habitual t’ai chi exercise on adiponectin, glucose homeostasis, lipid profile, and atherosclerotic burden in individuals with cardiovascular risk factors. J Altern Complement Med 2013;19:697-703.

20. Valizadeh A, Habibi A, Yousefi MR, Hashemi Ghorbanlo Z. The effect of 2 and 8 week aerobic exercises on insulin and glucose plasma, level and insulin sensitivity in obese middle age men. Ann Biol Res 2012;3:455-64.

21. Parsian H, Ezadi M, Khoshidi D, Khanali F. The effect of long-term aerobic exercise on serum adiponectin and insulin sensitivity in type 2 diabetic patients. J Jahrom Univ Med Sci 2013;11:36-43.

22. Mokhtari F, Esfarjami F, Kargar Fard M. The effect of combined aerobic exercise and barley B-glucan on lipid profile and glucose of women with diabetes type two. Iran J Endocrinol Metab 2014;13:340-51.

23. Suh SH, Paik IY, Jacobs K. Regulation of blood glucose homeostasis during prolonged exercise. Mol Cells 2007;23:272-9.

24. Sardar MA, Gaeini A, Ramezani J. The effect of 8-weeks of regular physical activity on blood glucose, body mass index, maximal oxygen uptake (Vo2 max) and risk factors cardiovascular diseases in patients with type 1 diabetes mellitus. EMRC 2007;10:91-7.

25. Bello AI, Owusu-Boakye E, Adegoke BO, Adjei DN. Effects of aerobic exercise on selected physiological parameters and quality of life in patients with type 2 diabetes mellitus. Int J Gen Med 2011;4:723-7.

26. Alizadeh Z, Kordi R, Hossein Zadeh Attar MJ, Mansournia MA. The effects of continuous and intermittent aerobic exercise on lipid profile and fasting blood sugar in women with a body mass index more than 25 kg/m: A randomized controlled trial. Tehran Univ Med J 2011;69:253-9.