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

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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 Tai 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.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,7 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

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structures, promotes breathing, affects the pancreas, reduces body fat percentage, increases cellular sensitivity to insulin, reduces insulin resistance\(^\text{[11]}\) and improves the insulin receptor function.\(^\text{[8]}\)

A study showed that Tai Chi was as effective as aerobic exercise in reducing blood glucose.\(^\text{[12]}\) 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.\(^\text{[10,13,14]}\)

Walking is the exercise of choice for diabetic patients.\(^\text{[15]}\) However, it may increase the risk for diabetic foot syndrome.\(^\text{[16]}\) 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.\(^\text{[17]}\) 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,\(^\text{[17]}\) 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\(^\text{[18]}\) and the modern 24-movement Yang style\(^\text{[19]}\) 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
Table 1: Comparing the groups respecting participant’s demographic characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Tai Chi (n=33)</th>
<th>Walking (n=33)</th>
<th>Control (n=34)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>51.63 ± 6.35</td>
<td>53.18 ± 4.99</td>
<td>51.85 ± 7.83</td>
<td>0.581</td>
</tr>
<tr>
<td>Mean SBP</td>
<td>125.45 ± 13.19</td>
<td>120.76 ± 14.20</td>
<td>128.38 ± 17.86</td>
<td>0.125</td>
</tr>
<tr>
<td>Mean DBP</td>
<td>82.42 ± 9.69</td>
<td>76.96 ± 9.99</td>
<td>80.58 ± 10.42</td>
<td>0.086</td>
</tr>
<tr>
<td>BMI</td>
<td>28.73 ± 3.25</td>
<td>28.28 ± 2.40</td>
<td>28.75 ± 2.47</td>
<td>0.737</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>FBG</th>
<th>Mean ± SD</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tai Chi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>149.82 ± 36.13</td>
<td>0.013</td>
</tr>
<tr>
<td>Posttest</td>
<td>124.21 ± 29.92</td>
<td></td>
</tr>
<tr>
<td>Walking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>134.12 ± 44.69</td>
<td>0.004</td>
</tr>
<tr>
<td>Posttest</td>
<td>118.03 ± 18.50</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>135.47 ± 24.54</td>
<td>0.055</td>
</tr>
<tr>
<td>Posttest</td>
<td>152.59 ± 43.62</td>
<td></td>
</tr>
<tr>
<td>Total groups</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>152.59 ± 43.62</td>
<td>0.150</td>
</tr>
<tr>
<td>Posttest</td>
<td>&gt;0.0001</td>
<td></td>
</tr>
</tbody>
</table>

SD: Standard deviation, FBG: Fasting blood glucose

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.\textsuperscript{[20,21]} Aerobic exercise promotes circulation, increases the function of glycogen synthase, facilitates glucose uptake by muscle tissue,\textsuperscript{[22]} and thereby reduces blood glucose.\textsuperscript{[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.\textsuperscript{[22]} Despite the known effectiveness of aerobic exercise in reducing blood glucose, Sardar et al. and Bello et al. reported that their several-week aerobic exercise interventions had no significant effects on blood glucose.\textsuperscript{[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.\textsuperscript{[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.\textsuperscript{[21]}

One study limitation was that we could not evaluate the effects of Tai Chi and walking on 3-month hemoglobin A\textsubscript{1c} due to the likelihood of high attrition rate after a 3-month follow-up. Studies with larger samples and longer follow-up periods are needed to determine the effectiveness of Tai Chi and walking in lowering hemoglobin A\textsubscript{1c}.

**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.

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

<table>
<thead>
<tr>
<th>Variable</th>
<th>Tai Chi</th>
<th>Walking</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>FBG</td>
<td>25.60 ± 30.29</td>
<td>16.09 ± 41.13</td>
<td>-17.11 ± 37.00</td>
</tr>
</tbody>
</table>

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

**Conflicts of interest**

There are no conflicts of interest.

**REFERENCES**


