

COULD LONG-TERM EXERCISE IMPROVE THE OBSTACLE-CROSSING ABILITY OF ELDERLY WOMEN? EFFECTS OF TAI CHI AND AEROBIC DANCE EXERCISES

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The purpose of this study was to evaluate the effects of long-term exercises (TaiChi (TC), aerobic dance) on the obstacle-crossing ability of elderly women, as well as to identify whether the exercise could considerably improve stability. Forty-five elderly women include TC, aerobic dance and no exercising groups participated in our study. They walked a short distance to cross the obstacle (30% of leg length). Results showed that long-term exercise had a positive effect on muscle strength and the practitioners used an obstacle-crossing strategy that increasing the force in medial-lateral and anterior-posterior directions of the trailing foot to cross obstacle. The TC strategy was better than aerobic dance in improving balance and increasing the height of the leg during obstacle-crossing.

KEY WORDS: Tai Chi, aerobic dance, elderly women, long-term exercise.

INTRODUCTION: Falls account for a number of injuries among the elderly (Ecosse, Sparrow, Murphy, & Newton, 2001). Approximately 50% of the elderly fall down because of walkway obstacles (Ecosse et al., 2001). Several studies attribute the high fall rate among the elderly to their poor stability, balancing ability (Wu, 2002) and lower extremity strength (Bellew, 2002). In former report, the TC has been proven to prevent falls (Alice & Wong, 2001) among the elderly, and the aerobic dance has been proven to improve the aerobic capabilities (Smol & Fredyk, 2012) of individuals. However, the effectiveness of these activities in preventing falls has attracted limited attention. Only a few of these studies analyzed the three-dimensional ground reaction force and compared TC with aerobic dance. Our research aimed to identify which exercise could considerably decrease the potential risks of falls among the elderly, to give advice and improve the quality of life among the elderly.

METHODS: Subjects: Forty-five healthy elderly women (age: 67.7 ± 2 years, weight: 63.3 ± 4.5 kg, leg length: 74.3 ± 2.5 cm, experience: 4.4 ± 2.1 years) who dominantly use their right foot in their activities. Include TC group ($n=15$), aerobic dance group ($n=15$) and no exercising group ($n=15$) participated in this study. **Testing Protocol:** A vicon system with eight cameras was placed 3 m from the left and right sides of a 12 m walkway. Two force plates were embedded in the walkway and one obstacle wood bar was placed in the middle of the two force plates with a height that was 30% of the leg length of the subjects (Zhang, Mao, Riskowski, & Song, 2011). There were five successful trials for each of the subjects' crossing over the obstacle. **Date Reduction:**

The kinematics data (stride length, foot clearance, maximum foot clearance, toe distance, heel distance) were normalized to the leg length. The ground reaction force data were normalized to the weight. **Data Analysis:** One-way analysis of variance (ANOVA) was used to compare differences among the three groups. SPSS 16.0 was used for statistical analyze, a type I error rate of 0.05 will be used to indicate statistical significance.

RESULT: Kinematics data: As table 1 shows, significant differences between TC group and other groups in maximum foot clearance and foot clearance. The TC group was significantly higher than other groups (aerobic dance, $p=0.002$; no exercising, $p=0.008$). However, there were no differences in stride length, crossing velocity, sing-leg stance time, toe distance and heel distance among groups.

Table 1: Kinematics comparison of three groups

	TC	aerobic dance	no exercising
Stride length (%)	1.36±0.23	1.27±0.27	1.41±0.15
Maximum foot clearance (%)	0.25±0.08	0.17±0.04**	0.18±0.04 ^{△△}
Foot clearance (%)	0.23±0.07	0.15±0.04**	0.16±0.05 ^{△△}
Crossing velocity (m/s)	1.52±0.54	1.49±0.57	1.42±0.35
sing-leg stance time (s)	0.73±0.09	0.72±0.07	0.71±0.06
Toe distance (%)	0.23±0.08	0.21±0.08	0.21±0.06
Heel distance (%)	0.23±0.07	0.22±0.05	0.23±0.05

**Significant difference between TC and aerobic dance, $P<0.01$

△△ Significant difference between TC and no exercising, $P<0.01$

Kinetics data: As the figure 3a shows, there were no significant differences between TC group, aerobic dance group and no exercising group in the first peak and valleys, but in the second peak, the force of TC group($p=0.001$) and aerobic dance group ($p=0.04$) was significantly bigger than no exercising group. As the figure 3b, significant difference between TC group and no exercising group in the local minimum of the medial-lateral force ($p=0.05$). In the second peak of the medial-lateral force of no exercising group was bigger than aerobic dance group ($p=0.028$).

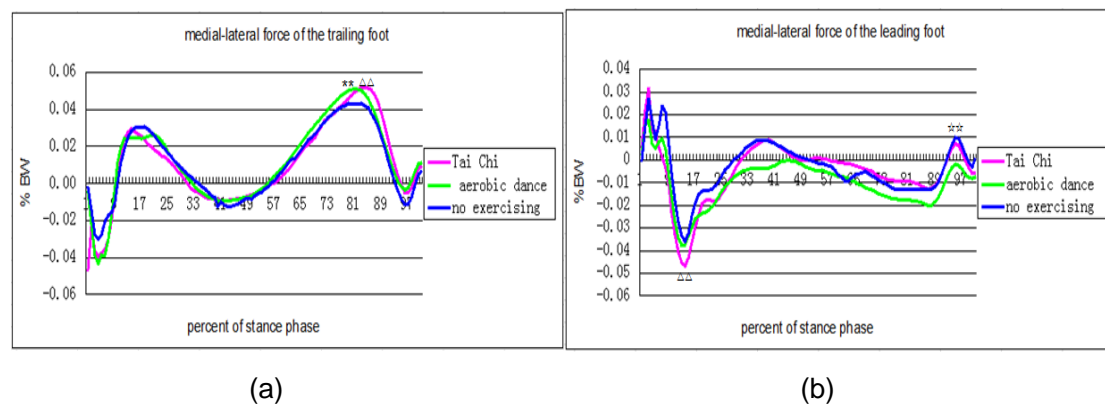
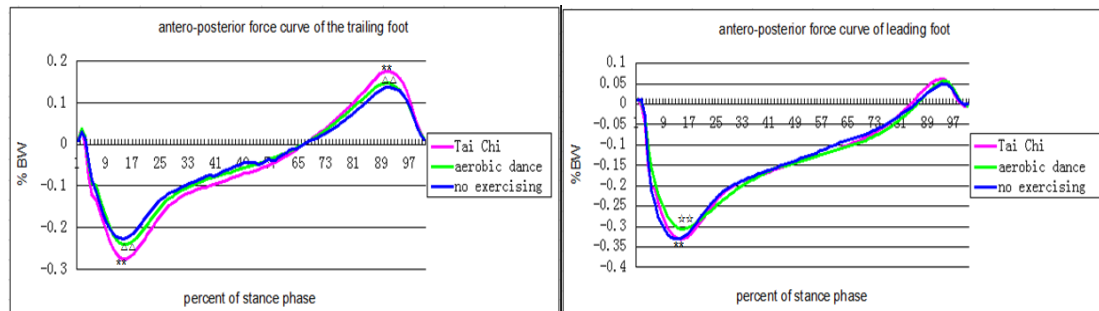


Figure 3: (a) medial-lateral force of trailing foot; (b) medial-lateral force of the leading foot. △△ Significant difference between TC group and no exercising group, $P<0.05$; ** Significant difference between aerobic dance group and no exercising group, $P<0.05$.

As the figure 4a shows, significant difference among TC group, aerobic dance group and no exercising group in the peak and valley values of the anterior-posterior force (TC with aerobic dance, $p=0.001$; TC with no exercising, $p=0.001$). As the figure 4b, significant difference among aerobic dance group, TC group and no exercising group in the valley of the anterior-posterior force (TC with aerobic dance, $p=0.002$; aerobic dance with no exercising, $p=0.002$).



(a)

(b)

Figure 4. (a) anterior-posterior force of trailing foot; (b) anterior-posterior force of the leading foot. ** Significant difference between TC group and no exercising group, $P<0.05$; ΔΔSignificant difference between TC group and aerobic dance group, $P<0.05$; ☆☆Significant difference between aerobic dance group and no exercising group, $P<0.05$.

DISCUSSION: Kinematics data analysis: As the table 1 shown, the TC group displayed a significantly higher value in foot clearance and the maximum foot clearance than aerobic dance and no exercising groups. Our founding was similar as the former research (Zhang and al., 2011). In order to avoid the obstacle, elderly would raise the leg as high as possible. There were some possible reasons for the TC participants to increase the height of leg lifts. When they were doing TC exercise, they need to lift their legs as high as possible to complete some unique action. For example, when they were doing White-crane-spreads-wings, one unique TC action, they need to lift their left foot as high as possible, so the TC exercise may increase the flexibility of the lower limbs (Bellew, 2002), so it could raise the height of the leg, avoid the feet touching the obstacles and avoid falling due to the obstacles. The foot clearance of aerobic dance and no exercising groups was not high enough, so it was very possible for them to touch the obstacles and fall down.

Dynamics data analysis: medial-lateral force analysis: Trailing foot strategy, the TC group and aerobic dance group increased the medial-lateral force to accomplish the action during the obstacle-crossing, this results was different compared with previous studies (Bellew, 2002), we guessed this was caused by the reason that long-term exercise increased old women's muscles strength(Bellew, 2002). **Leading foot strategy,** TC and aerobic dance groups may have better lower limb muscle strength (Bellew, 2002), so in the early support phase, they increased their force in medial direction to balance their body. In the middle support phase, the medial-lateral force of TC group was smaller compared with other groups, so it may reduce the possibility of body movement in medial-lateral direction. When doing TC

exercise, the practitioners learned to maintain balance and stability in various postural actions (Wong, Lin, Chou, Tang, & Wong, 2001). For example, TC used repeated up-and-down stepping motions that lift one foot above knee height of the trailing leg foot for a few seconds before returning it to the ground (Wong & al., 2001). For aerobic dance and no exercise participants, they increased their medial–lateral force during the middle support phase, so it was possible for them to lose balance in medial–lateral direction. **Anterior-posterior force analysis: Trailing foot strategy**, long-term TC and aerobic dance exercise may improve the old women’s muscles strength (Bellew, 2002), so the TC group and aerobic dance group increased the anterior-posterior force to accomplish the action during the obstacle-crossing. **Leading foot strategy**, the three groups increased the anterior-posterior force to control body during the obstacle-crossing. However, the result of no exercising group was bigger than aerobic dance group in anterior-posterior force. That may be due to the reason that no exercising group wanted to get rid of the state of single leg support, so the leading foot touched the ground actively to decrease the swing phase duration.

CONCLUSION: The long-term exercise practitioners used an obstacle-crossing strategy that increased the ground reaction force in medial–lateral and anterior-posterior directions of the trailing foot to cross obstacles and maybe the long-term exercise had a positive effect on muscle strength. Compared with aerobic dance exercise, the TC exercise may be better for elderly women to control balance, increase the height of leg clearance during obstacle-crossing to prevent falling. The TC exercise was a more suitable way for the elderly women to practice.

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