# EFFECTS OF TAI CHI PRACTICE ON POSTURAL SWAY DURING STANDING BALANCE

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The purpose of this study was to investigate the effects of Tai Chi practice on postural sway during standing. Thirty-eight older people participated during COVID-19 extended restrictions, a Tai Chi group (n=18, more than five years' experience) and a Control group (n=20, no Tai Chi experience). Postural sway was quantified under four different conditions:1) eyes open (EO); 2) eyes closed (EC); 3) eyes open and cross step with right leg forward (ER) and 4) cross step with left leg forward (EL). Significantly less postural sway was observed in Tai Chi group, particularly during EO and EL conditions. The findings of this study support the positive effects of Tai Chi practice on balance control. During the COVID-19, although older people in the nursing home limited their outdoor mobility, Tai Chi practice maintained their physical function during standing balance.

**KEYWORDS:** Tai Chi, older people, balance

**INTRODUCTION:** Falls are a significant public health problem, especially for older people (Khanuja et al., 2018). An important factor related to risk of falls in older people is impaired balance (Ambrose et al., 2015). Tai Chi has been promoted as a priority exercise for older people to prevent falls and consists of whole-body movements at a slow and controlled pace. Through long-term Tai Chi practice, community-dwelling older people improved static and dynamic balance control abilities and reduced unexpected falls (Jahnke et al., 2010; Li et al., 2005). Since the COVID-19 outbreak and quick spread, state and local governments have enacted numerous restrictions on human movement and physical interactions. Although those restrictions were necessary to slow the spread of COVID-19, they may have limited older people's ability to engage in sufficient physical activity (PA) to maintain physical function. It is essential to promote adequate PA related health in older people. Compared with other exercises which may require special equipment or outdoor space, Tai Chi becomes appealing for older people because it requires no equipment, little space, and can be led via video or done alone. It is unclear how COVID-19 related restrictions in a nursing home have impacted physical abilities among older people who regularly perform Tai Chi. During the COVID-19, older people typically limited their mobility and reduced their daily PA but Tai Chi practices was able to be maintained. Thus, the purpose of this study was to investigate whether Tai Chi practitioners have better postural control of body sway during standing balance under different experiment conditions than their non-Tai Chi peers within a nursing home during COVID-19 restrictions.

**METHODS:** Participants: A cross-sectional study was conducted to investigate standing balance in a sample of 38 older people (female 28/38, mean age 84.0±5.1 years) recruited from Hangzhou Sunshine Nursing Home. They were assigned to a Tai Chi group (female n=14/18, mean age 82.2±6.2 years) and control group (female n=14/20, mean age 85.6±3.2 years). In the Tai Chi group, all participants had at least five years' experience in Tai Chi performance and regularly practiced three times a week for one hour. Control group participants had no Tai Chi experience, but they strolled and had routine activities of daily living. During the past months, because of COVID-19 restrictions, the majority of older people had limited their activities and outdoor mobility in the nursing home. All participants were independent in their activities of daily living, and they were able to communicate and follow the measurement procedures. All of them had Mini-Mental State Examination (MMSE)

scores above 24 (Liu-Ambrose et al., 2008). Participants with any known neurological or orthopaedic disease were excluded. Other exclusion criteria included poorly controlled hypertension, diagnosis of metastatic cancer and any severe physical injury. This study was approved by the Ethics Review Board of Zhejiang University. All participants provided written informed consent.

Protocol: Participant demographic characteristics were collected in a face-to-face interview. Height and body composition (InBody H20B; Biospace Ltd., Seoul, Korea) including body mass, skeletal muscle mass, percent body fat, and body mass index (BMI) were measured. Participants were also assessed with the: MMSE, the Short International Physical Activity Questionnaire (IPAQ-SF) (Papathanasiou et al., 2009) and Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1989). Furthermore, the resting blood pressure (BP) and heart rate were measured (HEM-7211, OMRON). Their leg preference was determined by a ball kick, and all participants had right leg dominance.

Standing balance was measured in four randomized conditions: (1) EO: eyes open; (2) EC: eyes closed; (3) ER: eyes open and cross step with right leg forward (4) EL: eyes open and cross step with left leg forward. During trials, participants kept their arms crossed over their chests and were instructed to stand still. Two trials of 20 s duration were performed for each condition and participants stepped off and onto the balance board between trials. To examine the centre of pressure (COP) displacement during upright standing balance, participants were asked to stand barefoot on a Wii Balance Board (Nintendo, Kyoto, Japan). The balance board recorded vertical forces and moments of force along the X- and Y- directions. All data from the balance board were processed offline using MATLAB software (MathWorks, Natick, MA, United States) with custom-written scripts. The COP was calculated from the ground reaction forces and moments of force and then filtered using a 20 Hz low-pass, 2nd order, zero-lag Butterworth filter (Hao et al., 2021). The COP displacements were subsequently analysed in the anterior-posterior (AP) and mediolateral (ML) directions. The parameters used to quantify postural sway were: the range, standard deviation (SD), sway mean velocity, sway path length, and sway area (Verbecque et al., 2016). Mixed repeated-measures ANOVA with between-subject factors (group) and within-subject factors (condition) for all the parameters was used. When ANOVA revealed significant effects on the group, least significant difference *post-hoc* multiple comparisons were used to localize the differences. The significance level was set as $p<0.05$, two-tailed. All statistical tests were conducted using SPSS (IBM SPSS Statistics, Version 25, SPSS Inc., Chicago, IL, United States).

**RESULTS:** General Characteristic: There were no significant differences between the Tai Chi group and the Control group for general characteristics (Table 1, all $p>0.05$). For self-reported IPAQ-SF, the Tai Chi and Control group had different PA profiles ($p=0.007$) based on PA classification criteria (Papathanasiou et al., 2009). The Tai Chi group reported moderate PA at 88.9% (n=16/18) and high PA at 11.1% (n=2/18) whilst the Control group reported low PA at 31.6% (n=6/19), moderate PA at 42.1% (n=8/19), and high PA at 26.3% (n=5/19).

**Table 1** General characteristics of the participants

| Characteristic | Tai Chi (n=18) | Control (n=20) | All (n=38) |
|---|---|---|---|
| Height (cm) | 155.2 ± 7.7 | 157.3 ± 7.1 | 156.3 ± 7.3 |
| Body mass (kg) | 55.2 ± 7.4 | 58.4 ± 9.9 | 56.9 ± 8.9 |
| BMI (kg/m$^2$) | 22.9 ± 2.2 | 23.5 ± 2.8 | 23.2 ± 2.5 |
| Percent Body Fat (%) | 34.6 ± 6.1 | 33.1 ± 5.6 | 33.8 ± 5.8 |
| Skeletal Muscle Mass (kg) | 19.0 ± 3.3 | 20.7 ± 4.0 | 19.9 ± 3.7 |
| Systolic BP (mmHg) | 140.5 ± 17.2 | 137.1 ± 21.2 | 138.8 ± 19.2 |
| Diastolic BP (mmHg) | 71.2 ± 12.9 | 74.6 ± 11.7 | 72.9 ± 12.2 |

| | | | |
|---|---|---|---|
| Heart Rate (beat/min) | 67.3 ± 11.7 | 67.3 ± 10.9 | 67.3 ± 11.1 |
| PSQI scores | 7.0 ± 4.9 | 8.4 ± 4.8 | 7.7 ± 4.8 |
| PSQI habitual sleep efficiency (%) | 0.9 ± 0.2 | 0.8 ± 0.2 | 0.8 ± 0.2 |

Standing balance: No significant group by condition interaction effects were found for any parameters, except for MV_ML (Table 2). Significant main effects by group were found for Range_ML, Range_AP, SD_ML, SD_AP and Area, where the Tai Chi group had lower values than the Control group. Significant main effects of condition were observed for most parameters, but not for Path and Area. In particular, Range_AP (p=0.001), SD_AP (p=0.002) and Area (p=0.003) during EO, Range_ML (p=0.009), Range_AP (p=0.023), SD_ML (p=0.005), SD_AP (p=0.005) and Area (p=0.016) during EL, were significantly less for the Tai Chi group than for the Control group.

**TABLE 2** Overview of mean values and SDs for the measures of standing balance.

| | Group | EO | EC | ER | EL | Group *p* | Condition *p* | Group x Condition *p* |
|---|---|---|---|---|---|---|---|---|
| Range_ML(mm) | Tai Chi | 27.7 ± 4.7 | 35.6 ± 11.3 | 29.8 ± 18.1 | 22.7 ± 5.7* | **0.043** | **0.023** | 0.158 |
| | Control | 31.8 ± 9 | 38.2 ± 14.6 | 32.2 ± 12.1 | 35.1 ± 19.4 | | | |
| Range_AP(mm) | Tai Chi | 24.9 ± 5.9* | 35 ± 11.1 | 43.7 ± 14.3 | 39.9 ± 9.9* | **0.014** | **<0.001** | 0.383 |
| | Control | 32.7 ± 7.6 | 38.1 ± 14.3 | 47.7 ± 15.6 | 50.6 ± 19.3 | | | |
| SD_ML(mm) | Tai Chi | 6.1 ± 0.9 | 7.9 ± 2.4 | 6 ± 3.2 | 4.7 ± 1.2* | **0.040** | **<0.001** | 0.463 |
| | Control | 7.1 ± 2.4 | 8.8 ± 3.4 | 6.5 ± 2.4 | 6.7 ± 2.8 | | | |
| SD_AP(mm) | Tai Chi | 5.6 ± 1.4* | 7.7 ± 2.3 | 9.2 ± 2.9 | 8.5 ± 2.1* | **0.003** | **<0.001** | 0.477 |
| | Control | 7.5 ± 2.2 | 8.5 ± 3.1 | 10.8 ± 3.5 | 10.8 ± 3.1 | | | |
| MV_ML(mm/s) | Tai Chi | 6 ± 1.4 | 8 ± 2.5 | 8.3 ± 4.2 | 6.9 ± 2 | 0.191 | **<0.001** | **0.028** |
| | Control | 5.8 ± 1.3 | 7.9 ± 3.1 | 9 ± 2.5 | 9.6 ± 3.6 | | | |
| MV_AP(mm/s) | Tai Chi | 5.5 ± 1.1 | 7.6 ± 2.5 | 10.9 ± 3.8 | 10.6 ± 3 | 0.124 | **<0.001** | 0.984 |
| | Control | 6.6 ± 2.1 | 9.1 ± 3.9 | 12 ± 3.7 | 11.7 ± 2.5 | | | |
| Path(mm) | Tai Chi | 271.4 ± 53.8 | 367.2 ± 113.1 | 452.2 ± 183.1 | 414.3 ± 112.7 | 0.136 | **<0.001** | 0.434 |
| | Control | 294.2 ± 65.6 | 403.7 ± 146 | 491.2 ± 134.1 | 500.7 ± 131.4 | | | |
| Area($mm^2$) | Tai Chi | 599.1 ± 179.7* | 1186.1 ± 719.4 | 1350.7 ± 1439.5 | 828.7 ± 363.3* | **0.040** | **0.007** | 0.172 |
| | Control | 912.8 ± 383.2 | 1412 ± 1013.8 | 1461.6 ± 970.2 | 1739.3 ± 1586 | | | |

EO: eyes open; EC: eyes closed; ER: eyes open and cross step with right leg forward; EL: eyes open and cross step with left leg forward. Significance levels are indicated in bold.
*Significant difference between groups (p<0.05).

**DISCUSSION:** This study examined the effects of Tai chi practice on standing balance for older people who lived in a nursing home during the COVID-19 extended restrictions. Since the COVID-19 outbreaks, the nursing home had restrictive policies to prevent virus transmission, including lockdown from outside, isolation in own room, cancellation of group sports, and limited outdoor mobility. Generally, older people limited their daily routine activities and had reduced PA levels, for example they had to perform PA in their own room or in corridors. It seems that COVID-19 restrictions had a significant impact on the PA for older people's daily activities. However, Tai Chi practice was not interrupted for older people even during these special periods. In the Tai Chi group, their physical environment and daily routine activities remained the same as the Control group, but all participants reported regular Tai Chi practice during COVID-19 restrictions. It was found that less postural sway was observed in Tai Chi group who performed long-term Tai Chi than the control group, especially under the EO and EL conditions. These findings support positive effects of long-term Tai Chi practice on postural control and they are consistent with previous work that Tai Chi could improve postural stability (Ghandali et al., 2017; Guan & Koceja, 2011). In this study the Tai Chi group showed more stability in EO and EL conditions than the Control group. It seems that the positive effects on postural control favoured non-dominant leg tasks during standing balance. Similarly, findings were reported that long-term Tai Chi practisers had a better postural control under several conditions including EO, EC and other conditions

(Ghandali et al., 2017; Guan & Koceja, 2011). It has been noted that long-term Tai Chi practice produced substantial changes in individual physical conditions (Lesinski et al., 2015). Although older people suffered high risks during the COVID-19 outbreak and they limited their daily outdoor mobility in the nursing home (Jiang et al., 2020), we found that regular Tai Chi practice still maintained their physical function, improved balance, and reported a higher proportion of PA than other peers.

**CONCLUSION:** This study investigated the postural sway during standing balance between older long-term Tai Chi practitioners who continued practise during lock down and controls with no Tai Chi experience. We found that Tai Chi practitioners had better postural control under different conditions, in particular EO and EL during standing balance. Moreover, we suggest that regular Tai Chi practice could be a feasible exercise for older people to prevent falls and maintain their daily PA in nursing home during COVID-19 restrictions periods.

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