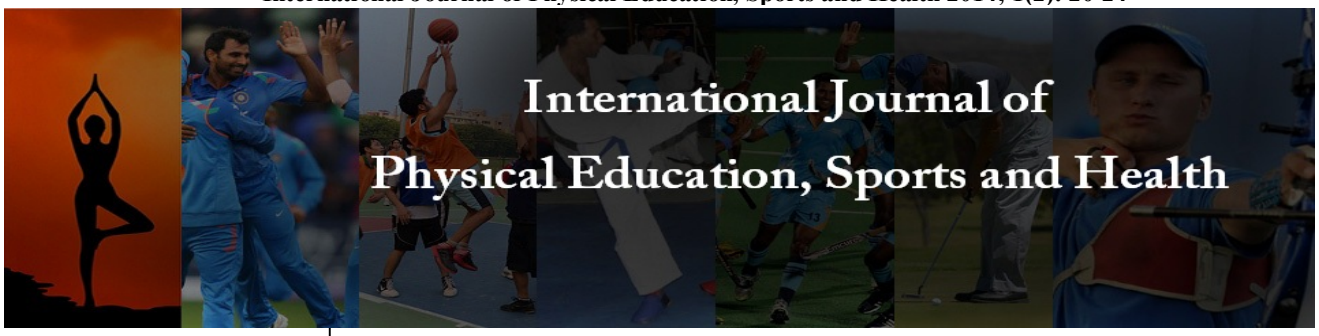

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Training Effects of Water Tai Chi on Health Indicators among Chinese Older Females in Hong Kong

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Abstract
The present study aimed to examine the effects of water Tai Chi on health indicators, namely blood pressure, body composition, and lipid profile among Chinese older females in Hong Kong. A group of apparently healthy older females aged 65 to 80 years old was recruited from local community senior centers. They were randomly assigned into three groups, namely water Tai Chi group (WTC), land Tai Chi group (LTC), and sedentary control group (CON). Participants in WTC and LTC groups have received 8-week Tai Chi training with three sessions per week and 60 minutes per session. The participants in WTC performed their Tai Chi in a swimming pool with water in depth of 1.0m. The results found that there was no significant group difference after the 8-week Tai Chi training, which indicated that WTC and LTC have similar training effects on the health indicators after the 8-week training. However, trends for means of SBP in WTC and %BF in LTC showed significant decreases from pre-tests to post-tests ($p < .05$) respectively, which suggested a longer training period is necessary for confirming these trends in future studies.

Keywords: Tai Chi, Water Exercise, Older Adult, Health indicators

1. Introduction
In Hong Kong, the proportion of people aged 65 and over is 12.6%, which is projected to be increased to 24.2% in 2029 [1]. It is expected this enlarging proportion of older adults will create a huge burden to Hong Kong in ageing-associated mortality, morbidity and costs. In addition, ageing and deconditioning usually cause changes in blood pressure, body composition, and lipid profile, which would result in functional independence of ageing people [2]. Based on numerous evidences of ageing and physical activity, health benefits from a regular physical activity provided a powerful basis for health promotion at both individual and community levels [3]. Tai Chi, as a traditional Chinese aerobic exercise, has claimed to be one of the most suitable exercises for older adults, especially for those with chronic illnesses, such as arthritis and other chronic conditions [4], pain and disabilities [5]. In addition, this low-impact and mind-body exercise has been shown to benefit one's health not only in physical aspects (e.g., flexibility, balance, muscular strength and endurance) [6], but also in psychological aspects (e.g., mood states, depression, and general self-efficacy) [7, 8, 9].Water is a supportive, low-risk exercise environment that may reduce the likelihood of acute injury while improving participation and adherence [10, 11]. Because of the reduced pressure and increased resistance, water exercise has allowed people to exercise longer time than on land with less demand on joints [12]. Related evidences have proved the health benefits of water exercise for people, especially for older adults with weaker lower limbs or patients with lower limb problems. The benefits include improving flexibility, strength and aerobic fitness in osteoarthritis patients [13], enhancing neuromuscular and functional fitness performance in healthy older females [14, 15]. In addition, one of the few studies that compared water-based activities to land-based activities showed greater improvement in functional reach in the aquatic environment [16]; and this improvement may be the result of increased confidence and reduced fear of falling that participants perceived when doing exercise in water. To gain maximum benefit from Tai Chi and water-based exercise, Argo (1998) first introduced Water Tai Chi (WTC) [17]. WTC is a combination of the principles of aquatic fitness and the graceful flowing movements of Tai Chi. It is performed upright in chest depth water in swimming pool. Its movements can be incorporated into warm-up, conditioning and cool-down phases of an aquatic class.

In considering WTC is a body-mind harmony exercise, the water provides an ideal environment for slow, rounded, flowing movements and helps use imagery-based commands when leading Tai Chi in the water. The water also provides about 12 times the resistance of air that may have better training effects when comparing with the effects from Tai Chi training on land [17]. Given the different environmental conditions for Tai Chi practice, health benefits from WTC and LTC were hypothesized to be different. The purpose of this study was to investigate the training effects between WTC and LTC on the selected health indicators namely blood pressures (BP), body composition [including body mass index (BMI) and percent body fat (%BF)], blood lipid profile [high-density lipoproteins (HDL-C), low-density lipoproteins (LDL-C), and triglycerides (TG)].

2. Methods

2.1 Participants

A total of 66 healthy older adults aged from 65 to 80 were recruited from the selected community senior centers in Hong Kong, of which 48 participants fulfilled all inclusion criteria and were randomly assigned into one of the three groups: Water Tai Chi-WTC (n = 16), Land Tai Chi-LTC (n = 16) and Control Groups-COT (n = 16). All participants were informed of the experimental procedures and asked to give their written consent for participating in this research as approved by Committee on the Use of Human & Animal Subjects in Teaching and Research of Hong Kong Baptist University. All participants were healthy and without any diseases that might negatively impact on their performances. None of them have experience in practicing Tai Chi or other similar martial arts.

2.2 Procedures

Participants were screened by using the standard PAR-Q form for ensuring that they were healthy for exercise. Participants in WTC and LTC underwent the 24-Forms Tai Chi training for 8 weeks, with three sessions per week and 60 minutes per session. Participants in the CON group received no Tai Chi training. They were asked to continue their usual life-styles during the intervention period. The training of WTC and LTC were conducted in Sport Centre with a swimming pool in a university in Hong Kong.

2.3 Intervention groups

WTC Group the Basic movements of the 24-Forms Tai Chi were taught and practiced, with the philosophy and principles of Tai Chi motions and the breathing techniques. The 24-Forms Tai Chi is one of the most popular forms of Tai Chi practiced in public [18, 19]. Each practice session consists of 10 minutes of breathing and stretching exercises on land followed by 50 minutes of Tai Chi practice in water (WTC). The program was conducted in the shallow end of swimming pool, with water depth of 1.0 m. The water temperature was 32 °C in average. *LTC Group* the LTC group received the same format of training as the WTC group but on land. The training sessions were carried out in an air-conditioning indoor activity room, with a constant room temperature of 23-25°C and humidity of 75-85%. The same Tai Chi instructor was appointed for both the LTC and WTC groups. *Control Group* The control group received no exercise training of any kind during the 8-week period.

2.4 Tests and Measurement

All participants received the following measurements and tests prior to and after the 8-week intervention: *Blood pressure (BP)* BP was the first indicator to be measured. It was tested manually by the mercury sphygmomanometer. Participants were required to sit near a table and rest at least 10 minutes before testing. For participants who reported being influenced by the "white coat effect", they were excluded from this test. *Body composition* BMI and % body fat were measured using Tanita, TBF-410 (Tanita Corp., Tokyo, Japan). All participants were asked to be bare-footed in these tests. *Blood lipid profile* three indicators for cholesterol were tested using Reflotron® system (Boehringer Mannheim, Germany) in terms of low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), triglycerides (TG).

2.5 Statistical Analysis

All the data was presented as mean ± SD. The two independent variables (IVs) were Group (i.e., WTC, LTC, and COT) and Time (i.e., pre-test and post-test). Dependent variables were systolic blood pressures (SBP), diastolic blood pressure (DBP), Body Mass Index (BMI), percent body fat (% BF), LDL-C, HDL-C, and TG. All the data was analyzed using a modified "intent-to-treat" methods (i.e., data from people who dropped out at the beginning of the study was not analyzed for results). Missing values were dealt by list-wise deletion. All tests for statistical significance are standardized at an alpha level of $p < .05$, unless other specified. A one-way between-groups ANOVA was conducted to find the group differences on the demographic and clinical data before the following analysis. To explore the overall changes of testing parameters among the three groups across the two-time tests, a two-way mixed ANOVA, Groups (3) x Time (2), was performed. Post hoc analysis with Bonfferoni correction was carried out to explore the difference between groups. In the case there was significant main effect for Time, the paired t-test was analyzed in each group to find the changes before and after intervention. All the data were analyzed using Statistical Package for Social Science (SPSS) version 21.0 (IBM, Chicago, IL).

3. Results

Due to the inconvenient training time and body discomfort, four participants dropped out at the beginning of intervention period, and the final study group has included 44 participants (WTC = 15, LTC = 16, and CON = 13). Although we have intended to recruit both male and female participants for this study, only six males were involved in this study. To eliminate any potential bias, only results from female participants were analyzed. The final number of participants was therefore adjusted to 38 (WTC = 13, LTC = 15, and CON = 10). The average attendance rate is 90% for each group. There was no harm/hurt reported during and after the intervention periods, indicating that both WTC and LTC are suitable and safe for the older adults to practice. The detailed information of participant attrition was described in Figure 1.

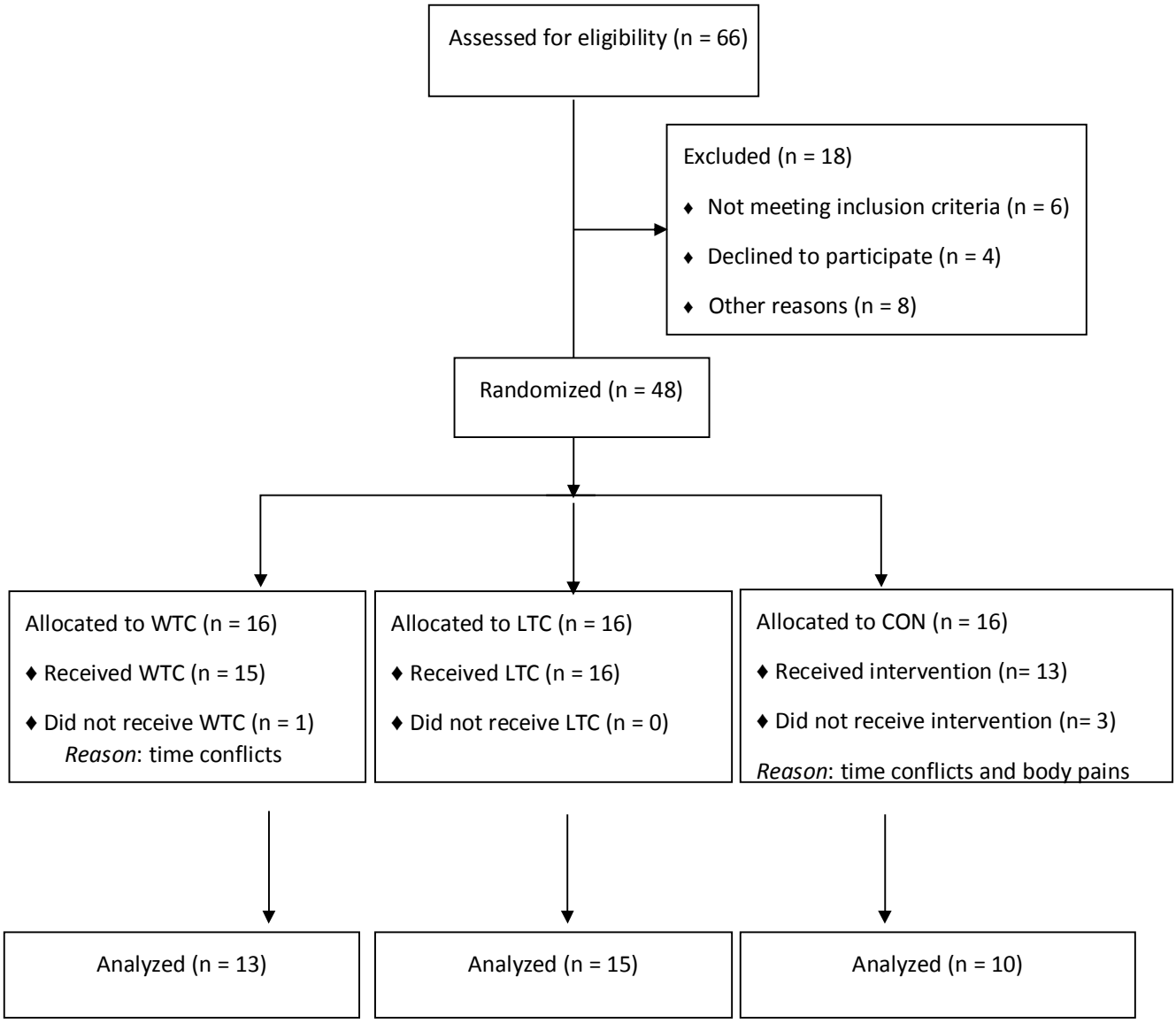

Fig 1: Flow of participants.

Demographic and clinical characteristics of participants for each group were presented in Table 1. Results from one-way ANOVA at the pre-test found no significant difference on these baseline parameters among the three groups ($p > .05$).

Table 1: Demographic and clinical characteristics for each group

	WTC (n = 13)	LTC (n = 15)	CON (n = 10)
Age (years)	69.4 ± 7.19	71.2 ± 6.05	74.6 ± 6.52
Height (cm)	152.9 ± 6.00	151.3 ± 5.20	149.1 ± 8.93
Weight (kg)	58.6 ± 9.70	50.8 ± 8.21	52.6 ± 12.9

Note. Mean ± SD; WTC = Water Tai Chi group, LTC = Land Tai Chi group, CON = Control group.

Given the analysis was based on a "modified intention-to-treat" method, a baseline difference was checked using one-way ANOVA and results showed no significant difference in all the testing parameters among the three groups ($p > .05$).

Results from two-way mixed ANOVA found no significant interaction effect of Group x Time on any of the testing parameters and no main effect for Groups as well. All these indicated that WTC did not improve in the testing parameters

within the eight-week training period, and the training effect from WTC did not differ from that of LTC. There were main partial η^2 = .13. Results from paired-t test found there were statistically significant decreases on the SBP in WTC, t (12) = 2.93, p = .013, and %BF in LTC, t (14) = 2.62, p = .020, respectively. The magnitudes of the decreases were quite large in SBP (d = .51) and small in %BF (d = .12). Although there effects for Time on SBP, F (1, 35) = 4.84, p = .034, partial η^2 = .12, and %BF, F (1, 35) = 5.28, p = .028,
was no statistically significant difference on other parameters before and after intervention, the trend of mean values suggest a longer training period is necessary for further confirmation of this trend in future related studies. Detailed values were presented in Table 3.

Table 2. Testing parameters in WTC, LTC and COT Groups before and after intervention

Physical parameters	WTC (n = 13)		LTC (n = 15)		COT (n = 10)	
	Before intervention	After intervention	Before intervention	After intervention	Before intervention	After intervention
SBP (mmHg)	145.4 ± 12.5	139.2 ± 11.5*	135.3 ± 15.7	128.1 ± 19.4	137.7 ± 22.1	134.1 ± 19.9
DBP (mmHg)	80.1 ± 10.7	75.9 ± 8.90	72.5 ± 8.03	71.5 ± 10.6	74.0 ± 17.2	73.7 ± 12.6
BMI	25.0 ± 3.68	24.9 ± 3.52	22.2 ± 3.62	22.0 ± 3.41	23.3 ± 3.80	23.1 ± 3.85
% Body fat	31.7 ± 5.84	31.5 ± 6.70	27.6 ± 6.01	26.8 ± 5.38*	30.4 ± 6.64	29.5 ± 6.75
HDL (mmol/L)	1.36 ± .210	1.16 ± .323	1.20 ± .353	1.20 ± .368	1.17 ± .552	1.18 ± .480
LDL (mmol/L)	4.95 ± .885	5.02 ± .812	5.20 ± .925	4.90 ± 1.04	4.83 ± 1.51	5.07 ± 1.25
TG (mmol/L)	1.43 ± .432	1.38 ± .272	1.54 ± .727	1.64 ± .952	1.88 ± 1.16	1.70 ± .934

Note. Mean ± SD; WTC = Water Tai Chi group, LTC = Land Tai Chi group, CON = Control group; *Significant differences between pre-test and post-tests.

4. Discussions

The present study investigated the training effects of an eight-week water-based and land-based Tai Chi programs on blood pressure, body composition, and lipid profile among a group of Chinese older females. Results showed no significant interaction effect of Groups x Time on all testing parameters, indicating that the three groups did not differ from each other. However, significant improvements on SBP in WTC group and %BF in LTC group were evidenced. All these suggest that longer training period is necessary for confirming these improvements in future related studies. There are increasing evidences showing that exercise has a positive effect on blood pressure [20]. Mechanism for the changes in blood pressure, as identified in a prior systematic review, is the decrease in the activities of the autonomic nervous system resulted from exercise training [21]. Tai Chi is an aerobic exercise with slow and controlled movements. It emphasizes not only on the external postures of the forms, but also includes many internal practices like breathing and meditation. All the practicing process is assumed to be relaxed. In considering the buoyancy and temperature in a water environment that can stimulate the response from blood pressure, WTC thus has more possibility to induce a positive effect on blood pressure. Our findings are in agreement with the results of some past related studies. Among which, Farahani and colleagues have proven that a 10-week aquatic aerobic exercise (including swimming) can substantially reduce the systolic blood pressure after intervention [22]. In the land-based TC group, there was a significant difference in percent of body fat before and after intervention but no significant group difference at posttest. Apart from the relatively shorter-term intervention period, exercise intensity and duration may play a significant role. Training-induced decrease of body fat from vigorous, long duration aerobic exercise has been well-reported in past studies. [23] However, Tai Chi is usually regarded as the moderate-intensity exercise and thus may not be able to make a significant effect on body fat [24]. If possible, a repeat study is recommended to be conducted, and exercise intensity and energy consumption should be monitored so as to differentiate the effect of WTC and LTC on % body fat. The preponderance of female participants is a limitation of our study and is a common problem among geriatric studies. In Hong Kong, it is the fact that female takes up the majority of participants in community senior centers. Future studies are recommended to recruit participants based on gender stratification to compensate any gender effect on outcome parameters, if any. Furthermore, since most related researches looking into the training effect of water exercise adopted a longer training period [13, 15, 25], and non-significant interaction results were showed in the present study, future investigation is suggested to adopt a longer training duration in the intervention programs.

5. Conclusions

The 8-week water-based and land-based Tai Chi training programs have similar training effects on blood pressure, body composition and lipid profile. Although no significant between-groups difference was found, trends for means of SBP in WTC and %BF in LTC have showed substantial decreases from pre-test to post-test (p < .05), suggesting a longer training period is necessary for confirming these trends in future studies.

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