Effects of Yuan Ji Dance on Standing Balance Control in Community-Dwelling Middle-Aged and Elderly People

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Abstract

This study investigated whether Yuan Ji Dance (YJD) helps to preserve balance function in middle aged and elderly populations. This study recruited 90 community-dwelling subjects (age 53-78) included a YJD group of 43 subjects with an average 2.7 years YJD and a control group of 47 healthy subjects with no history of YJD or regular practice of other exercises. From two-way (2x2) ANOVA test, This study compared the balance control of YJD pactitioner with subjects without YJD experience, and compared each group's subdomain middle age with elderly subjects. This study used sensory organization test (SOT) and unilateral stance test (UST) to investigate the balance control (e.g. somatosensory, visual, and vestibular conditions) for all subjects by the Smart Balance Master System. UST was significantly associated with age, but age had no significant interacting effects on exercise. The UST showed significant effects in the elderly and middle-aged subjects in the control group, but not the YJD group. Additionally, YJD showed significant main effects on performance of the eyes-opened and eyes-closed UST, but age had no significant interacting effects on exercise. The data show that YJD practitioner has a better vestibular function and a better standing balance control.

Keywords: morning activity, sensory organization test, unilateral stance test

1. Introduction

Researchers agree that exercise is an important factor in maintaining health and fitness. In recent years, many research labs have begun to design and test training programs specifically designed to improve performance on functional tests, including tests of standing balance (Shumway-Cook & Wollacott, 2001), and some studies have examined how different balance training programs can limit the loss of balance function in elderly adults (Province et al., 1995; Shumway-Cook & Wollacott, 2001; Wolf, et al., 1996).

Rubenstein & Josephson (2002) reported that the many factors associated with increased risk of falling include the loss of balance function, reduced muscle strength, gait and vision impairment. Other studies have examined the effects of multidimensional exercise (combinations of lower extremity strength and flexibility exercises, static and dynamic balance exercises, and participation in an aerobic activity) on balance, mobility, and fall risk in community-dwelling older adults. The data suggest that multidimensional exercise can help preserve balance and mobility function and reduce the likelihood of falls (Judge, Underwood, & Gennosa, 1993; Shumway-Cook, Gruber, Baldwin, & Liao, 1997). In recent years, YJD, a dance activity that combines Tai Chi Chuan (TCC), Chi-Gung, martial arts, and music, has become a very popular exercise activity in the Chinese community. The YJD exercise is a series of graceful movements linked together in a continuous sequence so that the body is constantly shifting from foot to foot (see Figure 1). Studies (Wolf et al. 1996) indicated that, for reducing the risk of falls, TCC training is more effective than static balance training. Scholars (Wong, Lin, Chou, Tang, & Wong, 2001) evaluated the effectiveness of TCC coordination exercise for improving postural stability in older individuals and found that TCC improved postural stability under challenging conditions. As a coordination exercise, TCC may reduce the risk of a fall by maintaining the ability to control posture. Postural stability is thus defined as the ability to maintain the projected center of mass (COM) within the limits of the base of support (BOS), referred to as the stability limits. Studies (Jane & Lin, 2004; Wu, 2006) employed COM to estimate YJD pactitioners' postural stability and both of the results YJD revealed positive effect on postural stability. Based above, recently Wu et al. (2010) analyzed the dynamic balance effects of YJD and found that YJD has beneficial effects on general cognitive and perceptual-motor functions.

Additionally, the article reported that low-middle intensity exercise such as YJD positively affects balance control by improving proprioception (Chung, Wu, & Lin, 2005). Apparently, YJD also helps to develop or maintain high vestibular sensitivity in elderly people by reducing the weight of vision.

(1) (2) (3)

Figure 1 Yuan Ji Dance forms.

Figure 1 Illustrates the sequence of the fundamental postures and movements: (1) single-leg rising; (2) side-load posture; (3) cross-legged squat. The photographers in this article have been agreed with the photographer's right and issued on the consents. The vast majority of YJD practitioners are older adults. Although studies indicated that YJD can help maintain static and dynamic balance, strength, flexibility, and coordination (Jane & Lin, 2004; Wu, 2006), these two YJD researches are still not enough proved as TCC clinical studies, such as how people adapt the senses to changing sensory conditions. Consequently, this article tried to investigate how the central nervous system (CNS) adapts multiple sensory inputs for postural control (Shumway-Cook & Wollacott, 2001) affected by YJD practice.

Because of a long period of time for a logitudinal study, this pilot study employed a cross sectional study to investigate the effect of YJD on balance control in people standing under reduced or conflicting somatosensory, visual, and vestibular conditions. By using computerized dynamic posturography, this study used SOT and UST to investigate the effects of YJD on balance function in middle aged and elderly subjects for obtaining more scientific evidences of YJD on health.

2. Methods

(1) Participants

This study recruited 90 middle-aged and elderly subjects (aged 53-78) living in a community midland of Taiwan. Every

subject was asked to fill in a questionnaire on personal health history, demographic characteristics and anthropometry.

The recruitment criteria included the ability to follow instructions given by the researcher. The exclusion criteria were any history of the following: chronic disease, including heart attack, hypertension, stroke; hip or knee joint replacement; serious orthopedic or neurologic problems; diabetes; resting ECG abnormalities; and abnormal responses on exercise ECG. Table 1 showed subjects' age and gender information in YJD group and control group. The 43 YJD practitioners were recruited from three YJD clubs which had the same YJD exercises training content. All subjects in this group had participated in YJD for at least one year (average, 2.7 years), and all subjects currently practiced YJD at least five times a week, and for at least 50 minutes a session.

Simultaneously, 47 healthy subjects were enrolled in a non-YJD control group with no history of YJD or regular practice of other exercises. The control subjects were recruited from several senior citizen centers. All subjects were community-dwelling and led a normally active lifestyle, but they did not engage in any regular exercise training for at least 5 yr. The two groups did not significantly differ in age, gender, height, weight, or body mass index (BMI) (see Table 2).

No subjects had a history cancer, renal disease, dementia, anemia, or asthma. 72% of the YJD group subjects and 68% of the control group subjects were without chronic diseases mentioned above. In terms of the health status of the YJD group, diabetes, hypertension, and arthritis were the three most common diseases, and two of the subjects had rheumatoid arthritis in the hands. The three major diseases in the control group were diabetes, hypertension, and kidney stones.

After the procedures and aims of the test were explained to the subjects, each subject was asked to complete an informed consent form before formal enrolment in the study. The study was reviewed and approved by the Institutional Review Board of Tao-Yuan General Hospital, Department of Health, Executive Yuan, Republic of China (Approval No. TYGH99003).

(2) Measures

A single physical therapist performed the Smart Balance Master System (NeuroCom Int. Inc., USA, 2004 Version 8.2) to test balance in all subjects. The test-retest reliability of the system has been verified (Ford-Smith, Wyman, Elswick, Fernandez, & Newton, 1995; Lichtenstein, Shields, Shiavi, & Burger, 1988). Figure 2 shows the procedure for performing the balance function examinations by SOT and UST, both of which were performed in the Balance Function Room of the Taichung Municipal Rehabilitation Hospital.

Table 1 Subjects' age and gender informations in Yuan Ji Dance group and control group

	Yuan Ji Dance group (n = 43)		Control group (n = 47)	
Age	Middle-aged (53-65 years)	Elderly (≥ 65 years)	Middle-aged (53-65 years)	Elderly (≥ 65 years)
	20	23	26	21
Gender	Female	Male	Female	Male
	23	20	25	22

Table 2 Basic information and exercise habits of Yuan Ji Dance and control groups

	Yuan Ji Dance group (n = 43)		Control group (n = 47)		*p*
	M	*SD*	*M*	*SD*	
Age (yr)	65.7	6.2	62.7	7.6	.49
Height (cm)	162.0	8.5	163.0	7.9	.35
Weight (kg)	63.1	9.1	63.1	11.3	.98
BMI (kg/m^2)	24.0	2.5	23.5	3.1	.38
Experiences of Yuan Ji Dancing (yr)	2.7	0.6	--	--	< .05

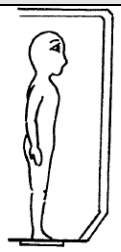
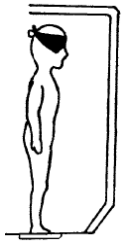
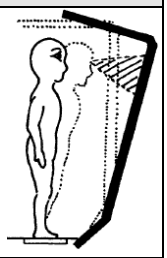
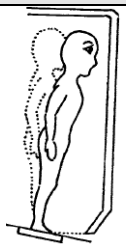
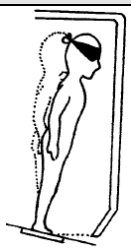
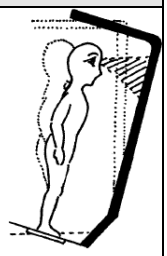
Figure 2 UST performed by Smart Balance Master (version 8.2) system.

(3) Procedures

The subjects were instructed to eat and exercise normally on the day before the test. However, they were asked not to consume alcohol. The subjects were also asked to wear light clothes on the day of the test. The harness always released and was to prevent the subject having an injury when the subject fell. Whenever a subject showed any discomfort during the test, the test was immediately stopped and the subject was asked to return for a retest on another date. During the test, each subject wore the most comfortable belt size provided by the system. The order of the two tests was randomized, and the interval between the two tests was five minutes.

The SOT exposes the subject to six sensory conditions consisting of all combinations of normal (fixed), eyes closed, and sway-reference visual and support surface sensory conditions (Kast & Lankford, 1986; Wolfson et al., 1992). The six conditions of the SOT protocol assess the ability of the subject to use visual, vestibular, and somatosensory inputs effectively for maintaining balance, and the ability to select the inputs that provide the functionally most appropriate orientation information under varying conditions (Figure 3). Specific sensory balance problems are best characterized by quantifying relative differences in the equilibrium scores among the six sensory conditions. Relative differences in scores are quantified as the ratio of the score for one sensory condition to that of another sensory condition. Table 3 summarizes equilibrium score ratios and their physiologic functions.

The subjects were asked to stand on the force plate of the instrument in bare feet with their hands hanging naturally on both sides of the body. They were then asked to maintain a balanced stance while looking at the screen in front of them. The test was performed for 20 seconds under each condition, and the average score for three trials was recorded.

Condition	1	2	3
			
Vision	Normal	Absent	Sway Referenced
Support	Fixed	Fixed	Fixed
Condition	4	5	6
			
Vision	Normal	Absent	Sway Referenced
Support	Sway Referenced	Sway Referenced	Sway Referenced

Notes: Condition 1: Eyes open and fixed surface and visual surround
Condition 2: Eyes closed and fixed surface
Condition 3: Eyes open, fixed surface, and sway referenced visual surround
Condition 4: Eyes open, sway referenced surface, and fixed visual surround
Condition 5: Eyes closed and sway referenced surface
Condition 6: Eyes open and sway referenced surface and visual surround

Figure 3 Six sensory conditions tested by SOT protocol.

Table 3 Definitions of sensory analysis ratios and ratios obtained in the sensory orgnization test

Sensory Ratios	Description
SOM ratio = $\frac{\text{Condition 2}}{\text{Condition 1}}$	Patient's ability to use input from the *somatosensory system* to maintain balance
VIS ratio = $\frac{\text{Condition 4}}{\text{Condition 1}}$	Patient's ability to use input from the visual system to maintain balance
VEST ratio = $\frac{\text{Condition 5}}{\text{Condition 1}}$	Patient's ability to use input from the vestibular system to maintain balance

Notes: SOM: Somatosensory system
VIS: Visual system
VEST: Vestibular system

Sensory organization and standing balance were evaluated using a sensory organization test (SOT) and unilateral stance test (UST), respectively. Single leg standing balance was measured in a unilateral stance test (UST) with the Smart Balance Master System. Participants stood barefoot on their non-dominant leg for ten seconds. (The dominant leg was defined as the one each participant reported using to kick a ball.) (Fong et al., 2011). The non-dominant leg was tested because it is usually the supporting leg during YJD. The standardized testing posture was arms by the side of trunk, eyes looking forward at a distant visual target and the hip of the non-supporting leg flexed at 45° so as to resemble the starting position of a front kick in YJD. The sway velocity of the center of pressure (COP) was recorded by the machine Smart Balance Master System. Three trials were performed with a ten-second rest in between. The mean COP sway velocity across the three trials was obtained and used for analysis. Previous study has shown that the test-retest reliability of the UST is good with an intraclass correlation coefficient of .77 (Fong et al. 2011c).

The UST required the subject to stand on one leg on the force plate of the instrument with eyes either open or closed, with hands on the hips, and with the non-weight-bearing leg (left or right) slightly flexed at the hip and knee. The four items in the test were performed randomly, and the results for each item measured three times. Subjects were instructed to remain as motionless as possible. The swaying of the body weight center during the UST was measured by deviation from the center of pressure on the force plate (Ross, Guskiewicz, Gross, & Yu, 2009).

(4) Data analyses

Two-way (2x2) ANOVA was used to test the effects of the two factors YJD exercise (YJD practitioner and non-YJD practitioner) and age (middle age and elderly) on standing balance control. The SPSS 12.0 package software was used to perform statistical analyses, and descriptive statistics were used to compare the basic information for the two sets of subjects. The significance level was set to .01.

3. Results

This study compared the balance control of YJD pactitioner with subjects without YJD experience, and compared each group's subdomain middle age with elderly subjects. From two-way (2x2) ANOVA test, this article tried to demonstrate some balance control performances related to effects of YJD exercise.

(1) Effect of YJD on sensory organization in the middle-aged and the elderly

Table 4 summarizes the descriptive statistics for balance in middle-aged and elderly YJD practitioners and non-YJD practitioners. Two-way ANOVA showed: (1) under conditions 1-5, a significant main effect of age on vestibular function; i.e. the performance of the elderly subjects was worse than that of the middle-aged subjects; (2) under conditions 1-6, a significant main effect of exercise on vestibular function; i.e., vestibular function was better in the subjects who practiced YJD than in the control group; and (3) under conditions 1-3, a significant main interacting effect of age. The elderly and middle-aged subjects significantly differed in the control group, but not in the YJD group. In the middle-aged group, the dance group and control

group did not significantly differ except under condition 3. In the elderly group, the dance group performed better that the control group did.

(2) Effect of YJD on stability in the unilateral stance test in the middle-aged and elderly

A significant main effect of age and main effect of exercise were observed in the performance of the eyes-open UST (right leg or left leg) (Table 4), but age showed no significant interaction with exercise. The results showed that the swaying in the UST increased with age and that this effect was smaller in YJD practitioners than in controls of the same age group.

Exercise also significantly affected performance of the eyes-closed UST (right leg or left leg) (Table 4). Regardless of age, YJD practitioners was better than controls on swaying of the eyes-closed UST.

Like TCC, YJD has become a popular exercise activity in the Chinese community in recent years. The YJD is characterized by simple and easily learned steps that can guided by elegant music and posture (Jane & Lin, 2004). This study used the Smart Balance Master System to determine whether YJD would improve balance or not with the performance of sensory information and sensory organization tests.

(4) Findings in Age differences

Middle age and elderly groups significantly affected the results for vestibular sense obtained under conditions 1-5 of the SOT. Scholars (Cohen, Heaton, Congdon, & Jenkins, 1996) reported that SOT data showed significant age-associated decline in overall score and changes in movement strategy. Their experimental results also suggested that the parts of the vestibular system involved in balance show age-related decline throughout life.

In the UST (eyes-open or eyes-closed), balance declined significantly in the elderly group. This finding is consistent with the widespread belief that the sighted elderly showed less body sway than the low vision and blind subjects in sensory conditions where they benefited from visual inputs to help them maintain standing balance (Chen, Fu, Chan, & Tsang, 2011; Desai, Goodman, Kapadia, Shay, & Szturm, 2010).

In the UST (eyes-open or eyes-closed), YJD practitioners showed significantly better balance compared to similarly aged subjects who rarely exercised. The literature agrees that falls are an outcome of bilateral vestibular hypofunction (Herdman, Blatt, Schubert, & Tusa, 2000) and that vestibular rehabilitation therapy can effectively reduce the occurrence of falls (Macias, Massingale, & Gerkin, 2005).

Table 4 Comparison of balance performance in middle-age and elderly YJD practitioners and non-YJD practitioners

	Middle-aged		Elderly	
	Control group (n = 26)	Yuan Ji Dance group (n = 20)	Control group (n = 21)	Yuan Ji Dance group (n = 23)
Sensory organization test				
Condition 1 *,†,‡	94.9 ± 3.1	93.6 ± 3.7	85.9 ± 9.3	94.2 ± 3.7
Condition 2 *,†,‡	91.1 ± 5.3	93.3 ± 3.0	80.5 ± 10.6	91.7 ± 3.7
Condition 3 *,†,‡	87.8 ± 6.2	91.6 ± 2.2	77.1 ± 12.4	90.1 ± 6.9
Condition 4 *,†	85.7 ± 5.9	87.8 ± 5.5	74.4 ± 13.7	84.0 ± 11.2
Condition 5 *,†	69.5 ± 9.3	83.8 ± 5.1	57.5 ± 13.6	76.7 ± 12.0
Condition 6 †	61.3 ± 17.9	73.8 ± 9.7	59.7 ± 15.6	65.8 ± 17.1
SOM	0.97 ± 0.05	1.00 ± 0.03	0.94 ± 0.11	0.97 ± 0.04
VIS	0.91 ± 0.07	0.94 ± 0.08	0.87 ± 0.12	0.89 ± 0.11
VEST *,†	0.74 ± 0.10	0.90 ± 0.06	0.67 ± 0.13	0.82 ± 0.14
Unilateral stance test				
Eyes-open right-leg stance *,†	1.1 ± 0.7	0.7 ± 0.2	1.5 ± 0.4	0.9 ± 0.5
Eyes-closed right-leg stance †	2.2 ± 0.9	1.1 ±0.7	2.4 ± 1.1	1.1 ±0.6
Eyes-open left-leg stance *,†	1.0 ± 0.4	0.8 ± 0.2	1.5 ± 0.5	0.9 ± 0.4
Eyes-closed left-leg stance †	2.4 ± 1.0	0.8 ± 0.4	2.2 ±0.9	1.0 ± 0.6

Notes: * age effect ($p < .01$); † exercise effect ($p < .01$); ‡ age by exercise interaction ($p < .01$)

(5) Findings in sensory conditions

Our study showed that YJD significantly affected all six sensory conditions used to measure vestibular function in the SOT. The elderly subjects in this study showed good SOM scores as reported previously. Although balance degenerated with aging, those subjects practicing YJD were still maintained well balance ability through their high somatosensory and vestibular test performance.

Performance in the SOT, particularly during altered sensory conditions (sway stabilization and eyes closed), has also proven effective for distinguishing between fallers and nonfallers in community-dwelling older adults (Desai et al., 2010; Melzer, Benjuya, & Kaplanski, 2004; Wallmann, 2001). The important finding in this study that vestibular function in the YJD group was superior to that in the control group may be useful for designing therapies to help prevent falls.

Therefore, six sensory conditions of the SOT measure the sensory organization ability needed for postural control in stroke patients, the elderly, and children with postural control disorders (Cohen et al., 1996; Lee et al., 1998).

The ability to stand still on two legs or one leg is required for many functional activities in daily life. A study (Lord, Rogers, Howland, & Fitzpatrick, 1999) found that elderly fallers have significantly reduced proprioception in their lower limbs while Tsang and Hui-Chan (2003) found that elderly practitioners of TCC, a Chinese mind-body exercise similar to YJD, have significantly better acuity in knee proprioception compared to controls who do not practice TCC and also have greater limits of stability when shifting weight from one leg to another.

(6) Interacting effects of age on exercise

The interacting effect of age on exercise was statistically significant under conditions 1-3. The middle aged and elderly subjects significantly differed in the controls, but not in the YJD practitioners. Therefore, YJD apparently helps prevent the balance reduction caused by increased age. That is, although practicing YJD does not affect balance performance in the middle-aged, it can substantially benefit the elderly.

(7) Effects of YJD and TCC

A study (Tsang, Wong, Fu, & Hui-Chan, 2004) showed that, when standing under reduced or conflicting somatosensory, visual, and vestibular conditions, the balance performance of elderly TCC practitioners on SOT is comparable to that of young, healthy subjects.

This study applied the UST to understand static balance between the two groups and found that, when the control group (both middle-aged and elderly) stood on the right or left leg with their eyes closed, their body swaying was significantly increased. Additionally, when YJD practitioners of either age group assumed a unilateral stance with the eyes open or closed, they had better stability of the body center compared to the age-matched control group.

Although joint proprioception and vestibular acuity as well as lower limb muscle strength (Sturnieks, St George, & Lord, 2008) decline with age (Tsang & Hui-Chan, 2003), the present results showed that YJD can maintain balance function in the elderly, especially vestibular function. This phenomenon was also obviously supported by this study. People may partially compensate by relying mostly on proprioceptive and/or vestibular cues for balance (Herdman et al., 2000; Horak, Henry, & Shumway-Cook, 1997).

Chen et al. (2011) found that poor vision and blindness decrease balance control in the elderly. Thus, the risk of falls in the elderly is increased when they are unable to obtain a visual response. Fortunately, Gauchard, Jeandel, and Perrin (2001) revealed that low-energy exercises have the most positive impact on balance control by relying more on proprioception, also appear to develop or maintain a high level of vestibular sensitivity allowing elderly people practising such exercises to reduce the weight of vision.

4. Conclusions

For findings mentioned above, in the middle-aged and elderly, YJD practitioner has a better vestibular function and a better standing balance control. Therefore, YJD exercise may have a positive effect for elderly to fall prevention.

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元極舞對於社區中老年人站立平衡控制之效益

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摘　要

本研究旨在探討元極舞對於中高齡者平衡能力的維護是否有幫助。本研究招募 90 位社區中高齡者（年齡分布為 53~78 歲），其中 43 位受試者為實驗組平均有 2.7 年的元極舞經驗，其他受試者則為控制組沒有任何元極舞和其他規律之運動之經驗。統計分析以雙因子變異數分析觀察從事元極舞運動和年齡二個變數在平衡上的效應。所有受試者都以平衡測試系統 (Smart Balance Master System) 接受感覺整合測試 (SOT) 和單腳站立測試 (UST) 以評估其平衡控制能力（如：本體感、視覺、前庭覺）。在實驗組，不同年齡族群在單腳站立測試結果有顯著差異，但其與從事元極舞沒有交互作用。在控制組，高齡和中高齡受試者單腳站立測試結果呈現顯著差異，但是從事元極舞運動的實驗組在這項測試中則沒有顯著差異。此外，從事元極舞運動的實驗組在張眼單腳站立和閉眼單腳站立呈現顯著的主要效果，但是在此組別中年齡和參與元極舞並無交互作用。測試結果顯示元極舞的參與者有較佳的前庭覺和站立平衡控制。

關鍵詞：晨間活動、感覺整合測試、單腳站立測試