THE IMPACT OF CLASSICAL CHINESE DANCE ON THE GAIT OF THE ELDERLY – CROSS SECTIONAL STUDY

Chia-Ling Chen, Jia-Hao Chang

Department of Physical Education and Sport Sciences, National Taiwan Normal University, Taipei, Taiwan

This study was to explore the difference of gait between normal healthy elders and elders who experienced in classical Chinese dance. Subjects divided into 2 groups (7 subjects in classical Chinese dance group, 7 subjects in normal elderly group), data was collected at a single point in time from groups and used the APDM Movement Monitoring system to analysis gait patterns. The classical Chinese dance group showed improved gait metrics: smaller left circumduction (4.3±2.2 vs. 7.2±1.3, p=0.01), larger right foot strike angle (17.58±2.53 vs. 11.04±5.46, p=0.014), reduced trunk coronal motion (3.47±1.04 vs. 6.90±2.36, p=0.004), and decreased trunk transverse motion (5.78±.79 vs. 7.06±1.22, p=0.038). These results suggest classical Chinese dance maintaining elderly gait and stability, warranting further exploration as a geriatric therapeutic comparison.

KEYWORDS: Gait Analysis, Cross-Sectional Comparison, Inertial Sensor, Balance

INTRODUCTION: The investigation of gait and balance disorders in the elderly is essential due to their significant impact on health outcomes, including increased risks of falls, institutionalization, and mortality (Dewey et al., 2022; Fang et al., 2017). The importance of gait with balance in preserving functional abilities in older adults is a well-established fact, as evidenced by extensive research (Kerrigan et al., 1998). Elderly individuals with gait disorders face a 2.2 times higher risk of adverse outcomes (Osoba et al., 2019; Woollacott et al., 2002). Poor executive functioning in older adults is associated with slower walking speed, increased stride variability, more frequent falls, and diminished performance in complex mobility tasks (Van et al., 2004; Verghese et al., 2006).
In geriatric health, dance is recognized as a holistic intervention that not only improves emotional, social, and sensory well-being but also enhances physical health. It boosts strength, flexibility, balance, and coordination, effectively reducing fall risks in the elderly (Podolski et al., 2023). Classical Chinese dance, specifically, encompasses a broad range of whole-body movements, exercises and cultivating muscle strength, focusing particularly on the lower limbs. Traditional therapeutic methods have primarily focused on exercise-based interventions but classical Chinese dance emphasizes controlled movements, balance, and coordination, offering a distinctive blend of physical and cognitive challenges (Tsimaras et al., 2012; Keogh et al., 1985). This effectively reduces sports injuries, improves balance, and corrects posture and gait issues linked to pelvic asymmetry (Brown et al., 2005). Gait can be comprehensively described through distinct domains, including pace, rhythm, variability, asymmetry, postural control, and amplitude (Lord et al., 2013). The dance's rhythmic nature contributes to gait stabilization and regularization (Haputhanthirige et al., 2023).
Inertial measurement units were used in this study, knowing walking cadences and loads on foot contact angles, considered the presence of circumduction, a compensatory walking pattern where a leg swings in an arc-like path, often caused by joint mobility restrictions, muscle weakness, or neurological impairments, as seen in conditions like stroke or cerebral palsy (Carcreff et al., 2020). Focusing on foot strike and toe-off angles, which are important for fall prevention, gait analysis, and prosthetic design (Fang et al., 2018).
The dancing elderly seems have better physical activities. Due to the limited data on the impact of classical Chinese dance on the elderly, this study aims to explore the differences between elderly individuals who have practiced classical Chinese dance and those who have not. Based on observation, it appears that elderly people who have practiced classical Chinese dance exhibit better step conditions, flexibility, and body balance. The purpose of this study was to understand the benefits of this dance form for the elderly, and to provide foundational evidence for future related studies.

METHODS: Classical Chinese dance (CCD) group (N= 7, mean age = 63.0 ± 6.2 years, BMI = 22.5 ± 3.2) and Normal elderly (NE) group (N= 7, mean age = 63.1 ± 5.0 years, BMI = 21.9 ± 3.4) with both groups matched at baseline. The CCD group was elderly who had at least 5 months classical Chinese dance experience but the NE group did not have classical Chinese dance experience. Two groups had no related medical history such as skeletal muscle, nervous system, visual impairment and limb disorders, and all of them understood the purpose and experimental flow of this study.

All participants were instructed to wear comfortable, non-high-heeled footwear and clothing appropriate for the test. The protocol included standing still until a long tone sounded, walking at a natural pace at the first tone, forth on a 7-meter marked pathway at a comfortable speed and turn right walking back to origin. The sensors (Figure 1) are placed on 2 Wrist, 2 Foot, 1 Sternum and 1 Lumber. Particularly analyzing Cadence (number of steps per minute), Double Support (the percentage of the gait when both feet are on the ground), Lateral Step Variability (three consecutive foot placements made by the same foot), Circumduction (the maximum amount that the foot travels perpendicular to forward movement during an individual stride, positive values indicate movement to the outside), Foot Strike Angle (angle of the foot at the point of initial contact), Toe-Off Angle (angle of the foot as it leaves the floor at push off, the pitch of the foot when flat is zero), Toe-Out Angle (lateral angle of the foot during the stance phase), Lumber- Range of Motion (angular range of the lumber spine in the coronal, sagittal and transverse plane), Trunk - Range of Motion (angular range of the thoracic spine in coronal, sagittal and transverse plane), Turns Angle (rotational angle of the turn), Turns Duration (duration of the turn), Turn Velocity (peak angular velocity of the turn) (Osoba et al., 2019). Descriptive statistics (mean ± standard deviation) were applied for all the parameters. All data were analysed with IBM SPSS 23.0 software and significance level was set at α =.05 in independent sample t test.

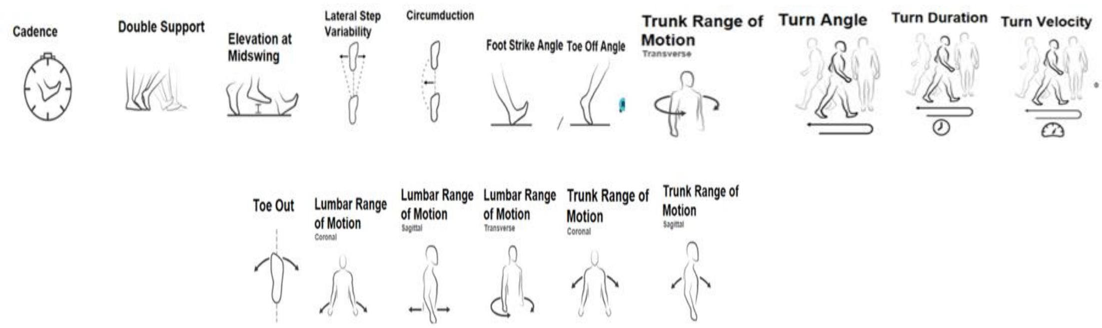

Figure 1: Specification of Stand and Walk (https://apdm.com/mobility/)

RESULTS: In the Stand and Walk test detailed in Table 1, significant biomechanical differences were observed between CCD and NE group. The CCD group exhibited a smaller left side circumduction (mean difference=2.9, *p*=0.01), a larger right side foot strike angle (mean difference=6.54, *p*=0.014), a reduced trunk coronal range of motion (mean difference= 3.43, *p*=0.004), and a decreased trunk transverse range of motion (mean difference =1.28, *p*=0.038) compared to the control group, indicating notable differences in movement mechanics. The gait parameter values of both groups were within the normal range for elderly people (Dapp et al., 2022).

DISCUSSION:

According to the research results, the CCD group demonstrated distinctive biomechanical patterns compared to the NE group, including reduced circumduction on the left side, an increased foot strike angle on the right, and limited motion in the trunk's coronal and transverse planes. These findings suggest notable differences in their movement mechanics. A decreased range of trunk movement in the coronal plane, indicating enhanced upper body stability, is

advantageous in sports requiring a strong core. Trunk stability is essential for effective, safe movement, and good gait circumduction, the circular motion of the leg during walking, is key for improved mobility and efficiency. This results in lower energy use and a smoother walking stride, especially beneficial for the elderly or those with certain medical conditions.
This aspect of gait is important for maintaining joint health, as it ensures controlled movement through the full range of motion in the hips, knees, and ankles, reducing the likelihood of joint-related issues. Additionally, efficient gait circumduction supports overall physical fitness by facilitating a form of exercise that benefits cardiovascular health and muscle strength, thereby improving the overall quality of life and physical fitness. Core training is effective in reducing fall risk, a significant concern in geriatric health due to its high prevalence and associated morbidity and mortality, as noted by Hupperets et al. (2009) and Muaidi et al. (2009).
The study results indicated that the CCD group exhibited a greater foot strike angle compared to a NE, yet both remained within the conventional range. Measuring foot strike angle is pivotal in understanding ankle plantar flexion during walking. This metric is critical for applications such as fall risk assessment post-tripping, abnormal gait identification, rehabilitation efficacy evaluation, and in the design of prosthetics and orthoses, which are instrumental in augmenting ambulatory functions in individuals with disabilities (Ensink et al., 2024).
Similar to Krebs et al. (2007), single leg movements enhance major muscle contribute to better cardiovascular health and increased strength and flexibility, further enhancing the overall physical condition of elderly individuals. Dancing benefits extend beyond physical improvements; it also offers cognitive advantages, including enhanced attention and spatial awareness, which might slow the progression of cognitive decline. Classical Chinese dance represents a promising intervention for addressing major geriatric health challenges. Furthermore, the feasibility of using inertial measurement units to measure objective gait function parameters in everyday life settings has been confirmed, underscoring the practical applicability of this intervention. In assessing gait asymmetries, the clinical relevance of statistically significant side-to-side differences depends on the magnitude of these variances, the specific characteristics of the participant group, and the particular gait metrics in question. Essentially, the physiological significance of these disparities must be evaluated within the context of the study's population and the targeted aspects of gait analysis.

Table 1: Stand and Walk test, reference data of gait parameters by classical Chinese dance (CCD) group and normal elderly (NE) group Data are presented as mean (standard deviation).

	CCD	NE	*P*
Cadence(L) (steps/min)	96.8±9.5	87.6±11.0	0.12
Cadence(R) (steps/min)	96.6±9.6	87.3±11.0	0.12
Double Support L(%GCT)	23.2±3.8	27.1±5.0	0.13
Double Support R(%GCT)	23.0±3.9	27.0±5.1	0.13
Lateral Step Variability L(cm)	2.13±.61	3.09±1.67	0.18
Lateral Step Variability R(cm)	2.48±1.07	2.42±1.32	0.93
Circumduction L(cm)	4.3±2.2	7.2±1.3	0.01*
Circumduction R(cm)	4.6±2.6	6.3±.8	0.13
Foot Strike Angle L(º)	16.82±3.22	11.04±7.35	0.08
Foot Strike Angle R(º)	17.58±2.53	11.04±5.46	0.01*
Toe Off Angle L (º)	36.83±4.81	32.90±3.97	0.12
Toe Off Angle R(º)	36.27±3.20	32.57±6.55	0.20
Toe Out Angle L(º)	12.52±10.65	7.57±8.87	0.36
Toe Out Angle R(º)	12.52±10.65	10.78±12.53	0.69
Lumber-Coronal Range of Motion(º)	4.90±1.40	4.96±2.08	0.95
Lumber-Sagittal Range of Motion(º)	4.90±1.40	5.74±1.47	0.46
Lumber-Transverse Range of Motion(º)	8.61±3.17	8.22±1.35	0.77
Trunk -Coronal Range of Motion(º)	3.47±1.04	6.90±2.36	<.01*
Trunk-Sagittal Range of Motion(º)	5.08±1.27	4.63±1.36	0.53
Trunk-Transverse Range of Motion(º)	5.78±.79	7.06±1.22	0.04*
Turns – Angle(º)	179.8±9.0	168.1±25.5	0.27
Turns – Duration(s)	2.0±.2	2.2±.5	0.38
Turns - Turn Velocity(º/s)	175.1±35.4	157.8±33.0	0.36

**P*<.05, L: left, R: right

CONCLUSION: The study observed significant differences in certain gait parameters between elderly individuals who participated in classical Chinese dance training and those who did not. We ensure that our revised conclusion avoids implying these differences indicate an improvement in gait quality or health outcomes. Instead, we present these findings as indicative of potential areas where classical Chinese dance may impact gait, meriting further investigation in future studies for their clinical relevance. In doing so, our conclusion focusing on descriptively presenting our findings, adhering to the data collected without making evaluative statements. The findings support that Classical Chinese Dance training could be a promising approach for addressing gait and balance disorders in older adults, although further research is needed to fully understand its effects across different gait and balance parameters.

REFERENCES

Brown, W. M., Cronk, L., Grochow, K., Jacobson, A., Liu, C. K., Popović, Z., & Trivers, R. (2005). Dance reveals symmetry especially in young men. *Nature*, *438*(7071), 1148-1150.

Carcreff, L., Gerber, C. N., Paraschiv-Ionescu, A., De Coulon, G., Newman, C. J., Aminian, K., & Armand, S. (2020). Comparison of gait characteristics between clinical and daily life settings in children with cerebral palsy. *Scientific reports*, *10*(1), 2091.

Dapp, U., Vinyard, D., Golgert, S., Krumpoch, S., & Freiberger, E. (2022). Reference values of gait characteristics in community-dwelling older persons with different physical functional levels. *BMC geriatrics*, *22*(1), 713.

Dewey, D. C., Chitnis, S., McCreary, M. C., Gerald, A., Dewey, C. H., Pantelyat, A., ... & Dewey Jr, R. B. (2022). APDM gait and balance measures fail to predict symptom progression rate in Parkinson's disease. *Frontiers in Neurology*, *13*, 1041014.

Ensink, C. J., Hofstad, C., Theunissen, T., & Keijsers, N. L. (2024). Assessment of Foot Strike Angle and Forward Propulsion with Wearable Sensors in People with Stroke. *Sensors*, *24*(2), 710.

Fang, X., Liu, C., & Jiang, Z. (2018). Reference values of gait using APDM movement monitoring inertial sensor system. *Royal Society open science*, *5*(1), 170818.

Hupperets MD, Verhagen EA, van Mechelen W. (2009). Effect of unsupervised home based proprioceptive training on recurrences of ankle sprain: Randomised controlled trial. *BMJ* 339: b2684.

Kerrigan DC, Todd MK, Della Croce U, Lipsitz LA, Collins JJ. (1998). Biomechanical gait alterations independent of speed in the healthy elderly: evidence for specific limiting impairments. *Arch Phys Med Rehab*; 79(3):317–322.

Krebs, D. E., Scarborough, D. M., & McGibbon, C. A. (2007). Functional vs. strength training in disabled elderly outpatients. *American journal of physical medicine & rehabilitation*, *86*(2), 93-103.

Lord, S., Galna, B., Verghese, J., Coleman, S., Burn, D., & Rochester, L. (2013). Independent domains of gait in older adults and associated motor and nonmotor attributes: validation of a factor analysis approach. *J Gerontology Series A: Biomedical Sciences and Medical Sciences*, *68*(7), 820-827.

Haputhanthirige, N. K. H., Sullivan, K., Moyle, G., Brauer, S., Jeffrey, E. R., & Kerr, G. (2023). Effects of dance on gait and dual-task gait in Parkinson's disease. *Plos one*, *18*(1), e0280635.

Keogh, J and Sugden, D. *Movement Skill Development*. New York, NY: Macmillan, 1985.

Muaidi QI, Nicholson LL, Refshauge KM. (2009). Do elite athletes exhibit enhanced proprioceptive acuity, range and strength of knee rotation compared with non-athletes? *Scand J M S S* 19: 103–112.

Osoba, M. Y., Rao, A. K., Agrawal, S. K., & Lalwani, A. K. (2019). Balance and gait in the elderly: A contemporary review. *Laryngoscope investigative otolaryngology*, *4*(1), 143-153.

Podolski, O. S., Whitfield, T., Schaaf, L., Cornaro, C., Köbe, T., Koch, S., & Wirth, M. (2023). The impact of dance movement interventions on psychological health in older adults without dementia: A systematic review and meta-analysis. *Brain Sciences*, *13*(7), 981.

Tsimaras, V. K., Giamouridou, G. A., Kokaridas, D. G., Sidiropoulou, M. P., & Patsiaouras, A. I. (2012). The effect of a traditional dance training program on dynamic balance of individuals with mental retardation. *The journal of strength & conditioning research*, *26*(1), 192-198.

Van Iersel MB, Hoefsloot W, Munneke M, Bloem BR, Olde Rikkert MG. (2004). Systematic review of quantitative clinical gait analysis in patients with dementia. *Z Gerontol Geriatr*. 37:27–32.

Verghese J, Lipton RB, Hall CB, Kuslansky G, Katz MJ, Buschke H. (2002). Abnormality of gait as a predictor of non-Alzheimer's dementia. *N Engl J Med*, 347:1761–1768.

Verghese J, LeValley A, Hall CB, Katz MJ, Ambrose AF, Lipton RB. (2006). Epidemiology of gait disorders in community-residing older adults. *J Am Geriatr Soc*, 54(2):255–261.

Woollacott M, Shumway-Cook A. (2002). Attention and the control of posture and gait: a review of an emerging area of research. *Gait Posture*, 16:1–14