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Effects of a Salsa Dance Training on Balance and Strength Performance in Older Adults

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Key Words
Elderly · Postural sway · Gait · Force production

Abstract
Background: Deficits in static and particularly dynamic postural control and force production have frequently been associated with an increased risk of falling in older adults. ***Objective:*** The objectives of this study were to investigate the effects of salsa dancing on measures of static/dynamic postural control and leg extensor power in seniors. ***Methods:*** Twenty-eight healthy older adults were randomly assigned to an intervention group (INT, n = 14, age 71.6 ± 5.3 years) to conduct an 8-week progressive salsa dancing programme or a control group (CON, n = 14, age 68.9 ± 4.7 years). Static postural control was measured during one-legged stance on a balance platform and dynamic postural control was obtained while walking on an instrumented walkway. Leg extensor power was assessed during a countermovement jump on a force plate. ***Results:*** Programme compliance was excellent with participants of the INT group completing 92.5% of the dancing sessions. A tendency towards an improvement in the selected measures of static postural control was observed in the INT group as compared to the CON group. Significant group × test interactions were found for stride velocity, length and time. Post hoc analyses revealed significant increases in stride velocity and length, and concomitant decreases in stride time. However, salsa dancing did not have significant effects on various measures of gait variability and leg extensor power. ***Conclusion:*** Salsa proved to be a safe and feasible exercise programme for older adults accompanied with a high adherence rate. Age-related deficits in measures of static and particularly dynamic postural control can be mitigated by salsa dancing in older adults. High physical activity and fitness/mobility levels of our participants could be responsible for the nonsignificant findings in gait variability and leg extensor power.

Introduction

Continuously greying societies in Western industrialized countries demand intense research efforts in the field of neuromuscular ageing. Specific consequences of neuromuscular ageing are tremendous decreases in different

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Table 1. Baseline characteristics by group

	INT (n = 14)	CON (n = 14)
Age, years	71.6 ± 5.3	68.9 ± 4.7
Body height, cm	167.1 ± 10.1	169.1 ± 8.6
Body mass, kg	72.3 ± 13.0	71.9 ± 13.0
BMI, kg/m^2	25.9 ± 4.2	25.1 ± 4.0
Sex, female/male	9/5	8/6
MMSE	28.5 ± 1.8	28.3 ± 0.8
CDT	all participants were classified as non-pathological	
Physical activity, h/week	11.5 ± 5.3	11.7 ± 8.3

Values are means and SDs. No group baseline differences were detected; $p > 0.05$.

components of postural control (e.g. reactive and steady-state balance) and force production (e.g. maximal strength, rate of force development, muscle power) mainly after the age of 60 [1–3]. These deficits are associated with an increased risk of falling in older adults [4, 5]. Thus, the promotion of balance and force production represents two important targets in the field of fall prevention. Traditionally, balance and resistance training have been applied to mitigate age-related processes in the neuromuscular system. However, the effects of resistance training appear to be limited to gains in force production. In fact, a systematic review of randomized controlled trials on the efficacy of resistance training on balance performance could not detect a clear effect on various measures of standing balance in older adults (effect size = 0.11) [6]. Balance training has proven to be effective in increasing measures of postural control and force production in seniors [7, 8]. However, social interaction during balance training is limited which might negatively affect both the motivation of the exercisers and adherence rate during training. Recently, Granacher et al. [9] suggested an intergenerational approach (i.e. seniors exercise together with children) in the promotion of balance in older adults to specifically address the motivation of the exercisers. Another form of enhancing motivation and social interaction during training is to implement dance programmes for the promotion of physical activity in general and balance and force production in particular. Thus, dance may provide a form of exercise that offers both a conditioning stimulus and a socially interactive and motivating activity that older adults would like to perform on a permanent basis [10]. A growing pool of literature indicates that different types of dance programmes (e.g. Turkish or Greek folklore dance, Latin dance, Tango) are effective in improving measures of postural control [11–15].

Salsa dance appears to be specifically suited for the promotion of balance and force production. In fact, salsa moves are particularly challenging for dynamic postural control and muscle strength/power due to frequent changes in direction and because the dance steps are performed on the toes of the feet. In addition, salsa specifically challenges the performance of movements to the rhythm of the music. Moreover, a stable walking pattern is characterized by low fluctuations of the gait rhythm. Thus, salsa dancing may improve spatiotemporal features of gait because both aesthetic dancing as well as stable walking require some sense of rhythm. Finally, over recent years salsa has become a very popular dance among young and middle-aged adults and might therefore also attract older adults. However, to the authors' knowledge, there is no study available that investigated the effects of salsa dancing alone on measures of postural control and force production in older adults.

Given that deficits in postural control and force production are associated with an increased risk of falling [4, 5], the objectives of this study were to investigate the effects of a progressive salsa dance programme on measures of static/dynamic postural control and leg extensor power in a cohort of older adults. Based on previously published studies [11, 13–15], it is expected that salsa dance improves static and particularly dynamic postural control as well as muscle power of the leg extensors in older adults.

Methods

Participants

Twenty-eight community-dwelling older adults between the ages of 63 and 82 gave written informed consent to participate in the study after experimental procedures were explained. The participants' baseline characteristics are presented in table 1. None of the participants had any history of musculoskeletal, neurological or orthopaedic disorders that might have affected their ability to conduct a salsa dance programme or to perform balance and strength tests. The participants were capable of walking independently without any assistive device and they had no prior experience with the applied tests. Participants were randomly assigned into an intervention group (INT) and a control group (CON). The randomization process was done using Research Randomizer, a programme published on a publicly accessible official website (www.randomizer.org). Local ethical permission was given by the EKBB (Ethikkommission beider Basel) and all experiments were conducted according to the latest version of the declaration of Helsinki.

Salsa Dancing

Participants of the INT group conducted a salsa dance programme over a period of 8 weeks (twice weekly) with a total of 16 sessions. The intervention period was chosen based on a previously published study showing that an 8-week Turkish folklore dance programme was effective in improving balance function in the elderly [15]. Each session lasted 60 min starting with a 10-min warm-up programme mainly consisting of salsa-specific static and dynamic balance exercises and ending with a 5-min cool-down programme (i.e. stretching). The intervention programme was given by a professional dance instructor in 2 separate exercise groups in order to keep the participant-to-instructor ratio small (1 instructor for 6–8 seniors).

Salsa is a partner dance that is characterized by Latin American rhythm and music. The dance programme mainly consisted of basic steps (e.g. 3-step weight change) and simplest movements of salsa in forward, backward, transversal and rotational directions. At the beginning of the programme the 3-step weight change was taught without a partner. This pattern typically uses 3 steps during every 4 beats, 1 beat being skipped. However, this skipped beat is often marked by a tap, a kick or a flick. Exercises like clapping hands, stomping the feet on the dance floor and walking individually to the rhythm of the music were incorporated in the acquisition phase. After the participants were able to accomplish the basic steps individually they were introduced to partner dance. Both men and women practiced leading while dancing salsa. This was accomplished in a first step by asking the lead person to guide their blinded partner over the dance floor. Progression during salsa dancing was realized by increasing the tempo of the music from initially 50 to 70 bpm at the end of the intervention. Of note, salsa can be danced to a count of up to 180 bpm. We further progressed from forward/backward directions to transversal and rotational dancing directions. In addition, salsa-specific moves like knee swings and hip rotations were continuously included in the programme. Finally, the participants learned the technique of toe dancing, which is a typical feature of salsa that demands high dynamic postural control and muscle power while moving with an extremely small base of floor contact.

Due to the small participant-to-instructor ratio, salsa dancing was safe without any intervention-related risk of falling. The participants of the CON group maintained their normal physical activities throughout the experimental period.

Testing Procedure

Upon entering the gait laboratory, all participants were kindly asked to complete two different questionnaires (the 'Freiburg questionnaire for everyday and sports activities'© [16] and the Mini-Mental State Examination, MMSE [17]) and one cognitive test to evaluate executive function (the Clock-Drawing Test, CDT [18]). Thereafter, participants received standardized verbal instructions regarding the test procedure with a visual demonstration of the balance and the power tests. Prior to testing, all participants performed one practice trial on each test instrument to rule out potential learning effects. Measurements of static and dynamic postural control were conducted in a counterbalanced order on a balance platform and a pressure-sensitive walkway. In addition, before- and after-tests included the analysis of jumping power on a force platform.

Testing Material

Balance Platform

Test circumstances (e.g. room illumination, temperature, noise) were in accordance with recommendations for post-urographic testing [19]. Static postural control was assessed by means of a balance platform (GKS 1000, IMM, Mittweida, Germany). The balance platform consists of four uni-axial sensors measuring displacements of the centre of pressure (CoP) in the mediolateral and anterior-posterior directions. For experimental testing the balance platform was firmly fixed on the floor. Participants were asked to stand on their dominant leg on the platform with their supported leg in 30° flexion, hands placed on hips and gaze fixed on a cross on the nearby wall (the fully extended knee corresponds to 0°). The dominant leg was determined according to the lateral preference inventory [20]. Participants were instructed to remain as stable as possible and to refrain from any voluntary movements during the trials. Data were acquired for 30 s at a sampling rate of 40 Hz [19]. Five parameters were computed from the time series of the CoP displacements. First, the displacements of the CoP in the anterior-posterior direction (CoPap, mm); second, the displacements of the CoP in the mediolateral direction (CoPml, mm); third, the total displacements of the CoP (CoPtot, mm), which represent the summed displacements in the mediolateral and anterior-posterior directions; fourth, the surface area covered by the trajectory of the CoP (CoParea, mm^2) with a 90% confidence interval, and fifth, the CoP speed (CoPspeed, mm/s), which indicates the total distances covered by the CoP divided by the duration of the sampled period. All of these parameters represent traditional balance measures, which are widely employed in clinical practice to assess individuals' postural control capacities during unperturbed stance [21]. Three trials were performed and their mean was used for further analysis. For all the assessed CoP variables, intraclass correlation coefficients (ICC) were ≥ 0.75, indicating an excellent intersession reliability [21].

Pressure-Sensitive Walkway

The walking pattern was determined during steady-state walking on an instrumented 10-metre walkway using the GAITRite© System (Havertown, Pa., USA). Participants walked with their own footwear at their own speeds, initiating and terminating each walk a minimum of 2 m before and after the 10-metre walkway to allow sufficient distance to accelerate to and decelerate from a steady state of ambulation across the walkway. Distribution of pressure during walking was monitored at 80 Hz, enabling spatiotemporal gait data to be collected. Because data from the left and right strides were not statistically different, only data from the left side were analysed. Besser et al. [4] reported that 5–8 strides are necessary for 90% of individuals tested with GAITRite instrumentation to have reliable mean estimates of spatiotemporal gait parameters. Temporal and spatial parameters of gait seem to be important in the assessment of mobility in community-dwelling elderly adults [22]. Thus, in a first step, means and standard deviations (SD) of stride time, stride length, and stride velocity were computed. Stride time was defined as the time (s) between the first contacts of two consecutive footfalls of the same foot. Stride length was defined as the linear distance (cm) between successive heel contacts of the same foot. Additionally, stride velocity (cm/s) was calculated as stride length divided by stride time. To determine gait variability, coefficients of variation (CV) were calculated for the above-mentioned parameters according to the following formula [(SD/mean) × 100] and used as outcome measures [23]. The smaller the CV value, the safer the walking pattern. Intraclass correlation coefficients for the calculated gait parameters ranged from ICC 0.79 to 0.98 [1].

Force Platform

Participants performed maximal vertical countermovement jumps (CMJs) while standing on a one-dimensional force platform (KistlerP type 9290AD, Winterthur, Switzerland). The vertical ground reaction force was sampled at 500 Hz. During the CMJs, subjects stood in an upright position on the force platform and were instructed to begin the jump with a downward movement, which was immediately followed by a concentric upward movement, resulting in a maximal vertical jump. Participants performed 3 CMJs with a resting period of 1 min between jumps. For each of these trials, subjects were asked to jump as high as possible. The mean of 3 trials in terms of maximal jumping power (W/kg) was taken for further data analysis. The intraclass correlation coefficient was calculated for CMJ power and amounted to ICC = 0.81.

Questionnaire

The 'Freiburg questionnaire for everyday and sports activities' [16] assesses basic physical activity level (e.g. gardening, climbing stairs), leisure time physical activity level (e.g. dancing, bowling) and sports activity level (e.g. jogging, swimming) of people between the ages of 18 and 78. Significant test-retest reliability was reported for the summed physical activity level (r = 0.56). Cross-correlation with maximum oxygen uptake revealed a significant correlation coefficient of r = 0.42 [16].

The MMSE is a valid test of cognitive function. It separates patients with cognitive disturbance from those without such disturbance. Test-retest reliability of the MMSE is high with r = 0.89. Cross-correlation with the Wechsler Adult Intelligence Score revealed a correlation coefficient of r = 0.78 [17]. According to Folstein et al. [17], a MMSE total score of less than 20 separates patients with dementia or functional psychosis from cognitively independently functioning participants and those with anxiety neurosis or personality disorder.

The CDT is a sensitive screening test for the evaluation of executive function [18]. The elderly participants were instructed to draw numbers in a given circle to make the circle look like a clock. Thereafter, subjects were asked to draw the hands of the clock to a point in time of their choice which, at the end of the test, they had to write down in digital form. Depending on the study consulted, inter-rater reliability for the CDT ranges between 75.4 and 99.6% [18]. Test-retest reliability can be classified as high with an r value of 0.90 [24]. Cross-correlation with the MMSE revealed a correlation coefficient of $r > 0.50$ [25]. As a result, the test distinguishes between pathological and normal test performance.

Statistical Analyses

Data are presented as group mean values ± SD, unless otherwise stated. A multivariate ANOVA was used to detect differences between the study groups in all baseline variables. Balance and strength parameters were analysed in separate 2 × 2 [groups (INT, CON) × tests (before, after)] ANOVA with repeated measures on test. Post-hoc tests with the Bonferroni-adjusted α were conducted to identify the comparisons that were statistically significant. The classification of effect sizes (f) was determined by calculating partial η^2_p. The effect size is a measure of the effectiveness of a treatment and it helps to determine whether a statistically significant difference is a difference of practical concern. f values of 0.10 indicate small, of 0.25 medium and of 0.40 large effects [26]. An a priori power analysis [27] with an assumed type I error rate of 0.05 and a type II error rate of 0.20 (80% statistical power) was conducted for measures of balance function [12] and revealed that 13 persons per group would be sufficient for finding statistically significant interaction effects. All analyses were performed using the Statistical Package for Social Sciences (SPSS) version 19.0. The significance level was set at $p < 0.05$.

Results

At baseline, all subjects met the inclusion criteria (i.e. MMSE; CDT) for participating in this study. The investigated results in the MMSE and the CDT indicate that the older adults of this study were cognitively healthy (table 1). Findings regarding the 'Freiburg questionnaire for everyday and sports activities' revealed that our participants could be classified as physically active (table 1). All subjects received treatment or control conditions as allocated. Fourteen participants completed the salsa dance programme and none reported any adverse events. Programme compliance was excellent with participants of the INT group completing 92.5% of the scheduled dancing sessions. Overall, there were no statistically significant differences in baseline values between the two experimental groups.

Standing Performance

The analysis based on performance during standing detected a main effect of time for the parameter CoPml [$F(1, 54) = 4.39$, $p = 0.05$, $\eta^2_p = 0.15$, $f = 0.42$], and a tendency towards a significant group × test interaction [$F(1, 54) = 3.20$, $p = 0.09$, $\eta^2_p = 0.11$, $f = 0.35$] for the variable CoPap. The inclusion of additional CoP parameters (e.g. CoPtot, CoParea, CoPspeed) did not reveal further significant findings (table 2).

Walking Performance

Stride Velocity. The analysis indicated a significant main effect of test [$F(1, 54) = 13.00$, $p < 0.001$, $\eta^2_p = 0.33$, $f = 0.70$] as well as a significant group × test interaction [$F(1, 54) = 11.73$, $p < 0.01$, $\eta^2_p = 0.31$, $f = 0.67$]. Post hoc analysis found that participants in the INT group significantly increased their stride velocity over the training period ($p = 0.001$, Δ11.3%) while the participants in the CON group showed no significant changes (fig. 1a). The main effect of group [$F(1, 26) = 0.01$, $p > 0.05$] was not significant.

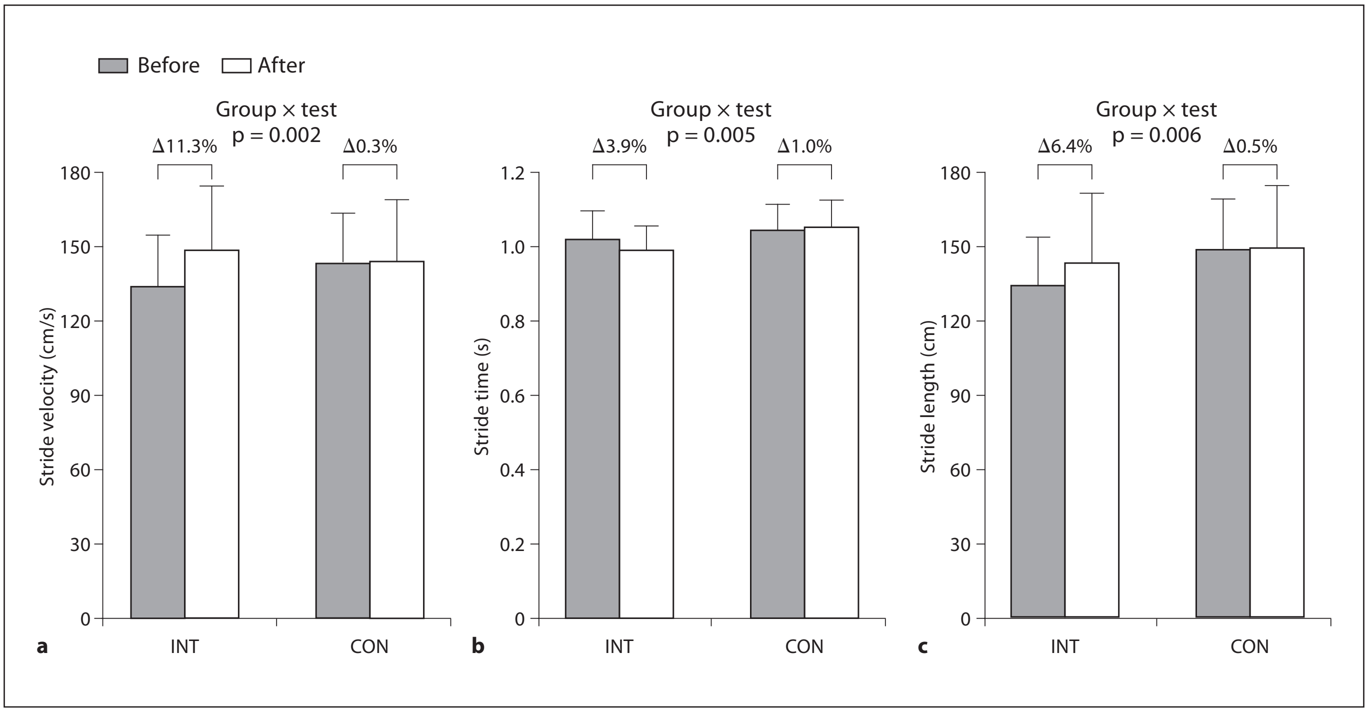

Fig. 1. Performance changes during the dancing period in stride velocity (**a**), stride time (**b**) and stride length (**c**) while walking on a pressure-sensitive walkway for the INT group compared to the CON group (mean ± SD).

Table 2. Outcome measures (ANOVA with repeated measures on test)

Measure	INT (n = 14)		CON (n = 14)		p value	
	before	after	before	after	time	time × group
Standing						
CoPtot, mm	1,984.4 ± 584.8	1,744.6 ± 670.7	2,192.3 ± 437.1	2,140.9 ± 457.7	0.076	0.243
CoPml, mm	1,210.5 ± 342.7	1,078.5 ± 441.0	1,448.8 ± 358.9	1,310.4 ± 297.4	0.046	0.960
CoPap, mm	1,315.0 ± 437.5	1,145.5 ± 459.9	1,335.1 ± 332.8	1,401.3 ± 403.4	0.440	0.085
CoPspeed, mm/s	67.1 ± 19.5	59.3 ± 23.0	74.3 ± 14.7	72.9 ± 15.6	0.093	0.241
CoParea, mm^2	15.6 ± 9.2	13.8 ± 7.4	16.4 ± 8.4	14.7 ± 9.6	0.461	0.994
Walking						
Stride velocity, cm/s	133.8 ± 20.2	148.9 ± 25.8	141.8 ± 14.4	142.2 ± 14.2	0.001	0.002
Stride time, s	1.02 ± 0.07	0.98 ± 0.07	1.04 ± 0.06	1.05 ± 0.07	0.018	0.005
Stride length, cm	136.8 ± 22.0	145.5 ± 26.8	147.6 ± 15.0	148.4 ± 13.3	0.001	0.006
Stride velocity CV, %	2.7 ± 1.5	2.4 ± 1.1	2.3 ± 1.0	2.4 ± 0.7	0.637	0.542
Stride time CV, %	1.7 ± 1.0	1.9 ± 0.6	1.4 ± 0.7	1.6 ± 0.4	0.332	0.916
Stride length CV, %	1.9 ± 0.8	1.9 ± 1.1	1.9 ± 0.8	1.7 ± 0.6	0.612	0.609
Power						
CMJ power, W/kg	14.0 ± 2.8	15.7 ± 3.5	16.2 ± 2.2	19.2 ± 2.9	0.000	0.098

Values are means and SDs.

Stride Time. The analysis revealed a significant main effect of test [$F(1, 54) = 6.35$, $p < 0.05$, $\eta^2_p = 0.20$, $f = 0.50$] as well as a significant group × test interaction [$F(1, 54) = 9.28$, $p < 0.01$, $\eta^2_p = 0.26$, $f = 0.59$]. Post hoc analysis found that participants in the INT group significantly decreased their stride time over the training period ($p = 0.001$, Δ3.9%) while the participants in the CON group showed no significant changes (fig. 1b). The main effect of group [$F(1, 26) = 3.62$, $p > 0.05$] was not significant.

Stride Length. The analysis detected a significant main effect of test [$F(1, 54) = 13.47$, $p < 0.001$, $\eta^2_p = 0.34$, $f = 0.72$] as well as a significant group × test interaction [$F(1, 54) = 9.15$, $p < 0.01$, $\eta^2_p = 0.26$, $f = 0.59$]. Post-hoc analysis found that participants in the INT group significantly increased their stride length over the training period ($p = 0.001$, Δ6.4%) while the participants in the CON group showed no significant changes (fig. 1c). The main effect of group [$F(1, 26) = 0.86$, $p > 0.05$] was not significant.

Stride-to-Stride Variability. In terms of gait variability, the analysis failed to detect significant main effects of time, group and group × test interactions for the CV of the stride velocity, time, and length parameters (table 2).

Power Performance

With regard to CMJ power, the analysis detected a significant main effect of time [$F(1, 54) = 41.75$, $p < 0.001$, $\eta^2_p = 0.74$, $f = 1.69$]. The main effect of group [$F(1, 26) = 4.32$, $p > 0.05$] and the interaction effect of group × test [$F(1, 54) = 3.11$, $p > 0.05$] were not significant (table 2).

Discussion

To the authors' knowledge, this is the first study that has investigated the impact of salsa dancing on intrinsic fall-risk factors (i.e. deficits in postural control and muscle power of the leg extensors) in older adults. Eight weeks of progressive salsa dancing resulted in: (a) a tendency towards significant improvements in selected measures of static postural control; (b) a significantly enhanced gait pattern in terms of increases in stride velocity and length, and concomitant decreases in stride time, and (c) no significant changes in gait variability and muscle power of the leg extensors.

The present findings are in accordance with the literature regarding the effects of dancing on measures of balance function in older adults. Federici et al. [11] assessed the impact of Latin dance in a randomized controlled clinical trial on measures of balance in community-based inactive seniors. Study participants (age range 56–68 years) were randomized to either a dance or a control group for 3 months. While the dance group participated in 60-min Latin dance (e.g. Merengue, Bachata) classes twice a week, the control group did not engage in any physical activity. Before and after the intervention period, balance was assessed using 4 different clinical tests (the Tinetti, Romberg, improved Romberg and Sit-Up and Go tests). The findings indicated significant improvements in balance capability in the dance group. Conversely, the control group showed a slight but not statistically significant deterioration in balance function. Outcomes from a short 4-item psychosocial survey (smoking, alcohol consumption, sexual habits, sleep quality) developed by the study investigators also demonstrated improved subjective assessments of sleep quality and sexual activity among subjects in the dance group. Furthermore, 17 of the 20 dance group subjects reported moderate to great satisfaction with the dance activity. Based on their results, the authors concluded that Latin dance may improve balance and hence be a useful tool in reducing the risk of falling in older adults.

In another study, Shigematsu et al. [13] determined the effects of dance-based aerobic exercise on indices of falling in healthy community-dwelling women aged 72–87 years. The intervention group performed an aerobic dance exercise (side stepping, fast walking, forward/backward stepping, leg lifts, etc.) for 60 min, 3 days per week for a total of 12 weeks. Most of the activities were accompanied by music with changing tempo. The main outcome measures included balance tests (i.e. single leg balance with eyes opened/closed, functional reach), strength tests (i.e. hand grip strength, keeping a half squat position), locomotion/agility tests (i.e. walking time around 2 cones, 3-min walking distance), and motor processing tests (i.e. hand-reaction time, foot tapping). After the dance programme, the intervention group showed significantly greater single-leg balance with eyes closed, improved functional reach and decreased walking time. However, measures of strength were not significantly influenced by dancing. The lack of finding regarding the impact of dancing on leg extensor power in our study can most likely be explained by the high fitness/mobility level of our participants with average sports-related physical activities of 11.5 h/week and an average spontaneous stride velocity of 133.8 cm/s. In fact, Frey et al. [16] reported a mean physical activity level of 9.9 h/week including basic, leisure time and sports-related activities for seniors aged 70 years and older. In addition, Oberg et al. [28] examined habitual gait speed in subjects aged 10–79 years and found that women and men between the ages of 70 and 79 years walked with an average speed of 115 cm/s. Thus, our participants' physical activity and fitness/mobility levels appear to be above the average values of older age-matched adults. Moreover, the training stimulus during salsa dancing might not have been specific enough to induce improvements in muscle power. It has frequently been reported that power training or high-velocity strength training have the potential to produce gains in muscle power in older adults [for a review see 29]. Thus, the principle of training specificity explains why we did not find improvements in leg extensor power in our study.

The present study revealed significant increases in stride velocity in the salsa dance group as compared to the control group. Given that the magnitude of age-related reduction in gait speed varies between 0.1 and 0.7% per year [28] and that decreases in gait speed are associated with an increased risk of falling [30] and functional decline [31], it is of great relevance that salsa dancing had the potential to increase gait speed in older adults. In fact, Hoxie and Rubenstein [31] reported that a walking speed of 122 cm/s is necessary to cross intersections safely, and observed that 96% of individuals aged 65 and over walk at a slower gait speed than this when crossing an intersection. Thus, the regular performance of salsa dancing may delay the onset of functional and mobility limitations and could help preserve the quality of life and independence of older adults.

This study did not detect significant effects of salsa dancing on spatiotemporal measures of gait variability in older adults. In contrast to our findings, Trombetti et al. [32] were able to examine significant decreases in stride length variability after 6 months of varied multi-task exercises, mostly performed to the rhythm of improvised piano music (i.e. Jaques-Dalcroze eurhythmics) in community-dwelling adults aged older than 65. In addition, the music-based exercise programme resulted in a reduced rate of falls and a lower risk of falling. Three methodological reasons can most likely explain the discrepancy in findings between our study and theirs. First, the duration of our salsa dance programme might not have been long enough to induce changes in measures of spatiotemporal gait variability. Thus, future studies should extend the intervention period beyond 8 weeks to find out whether additional adaptive processes in the gait pattern can be observed following salsa dancing. Second, in our subjects, spatiotemporal gait variability scores were already low at baseline (e.g. 1.7% stride time CV) indicating that the gait pattern was rather stable. In contrast, Trombetti et al. [32] reported a baseline stride time CV of 5.3%. Kressig et al. [33] were able to identify a critical threshold for stride time CV (>4%) that was strongly associated with fall events in older inpatients. Based on these findings, it can be concluded that the gait pattern of our subjects was stable and risk of fall was low, whereas the gait pattern of the participants in the study by Trombetti et al. [32] was unstable and risk of fall was high. Third, with reference to the principle of training specificity, Jaques-Dalcroze eurhythmics may have the potential to improve gait variability due to the high demands of attention while moving to the melody and rhythm of improvised and quickly changing piano music. Salsa dance on the other hand lacks this improvised and unexpected music-imposed movement and pattern change, which might explain the missing effect on gait variability.

Conclusions

This study proved that salsa dancing is a safe, feasible and highly enjoyable exercise programme for older adults. Salsa dancing seems to specifically be well suited for the promotion of static and particularly dynamic postural control, which makes it a useful intervention in reducing the risk of falling in older adults. However, if the goal is to induce improvements in spatiotemporal gait variability and muscle power, more specific training stimuli appear to be necessary. Recently, it has been reported that Jaques-Dalcroze eurhythmics has the potential to improve measures of gait variability and to reduce fall rate in older adults [32]. Furthermore, a recent systematic review on the effects of power training indicates that this training regimen enhances both muscle power and functional performance in older adults [29]. Taken together, these findings suggest that dance programmes should include improvising movement elements to the rhythm of music and power-specific exercise elements in order to effectively promote various components of postural control and force production. However, this hypothesis needs to be verified in future studies.

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