TITLE PAGE

Postural stability of older female Scottish country dancers in comparison to physically active controls.

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Abstract

Physical activity assists older individuals' functional ability and postural stability. Recently, Scottish country dance (SCD) was reported as being a beneficial form of physical activity for functional ability in older females. This study aims to examine the effect of SCD on postural stability. Scottish country dancers (*n*=20) were compared to physically active controls (*n*=33) for static postural sway measured on a force platform. The Romberg and Tandem stances were used, under 'eyes open' and 'eyes closed' conditions. 95% ellipse area and sway velocity were calculated from the center of pressure displacement. 95% ellipse area was the same for both groups in all tests. The control group had greater sway velocity for all tests (*p*<0.01) except Tandem eyes closed. SCD participation resulted in similar postural sway as participation in other physical activities, however non-dancers may need a greater amount of regulatory activity to maintain balance.

Keywords: aging, balance in elderly, dance, functional ability

Postural stability of older female Scottish country dancers in comparison to physically active controls.

Introduction

Recent reports and initiatives have highlighted the importance of physical activity in older adults, not only for the prevention of disease, but more specifically on postural stability, in a bid to reduce the incidence of falls in this population (American College of Sports Medicine et al., 2009; Howe, Rochester, Neil, Skelton, & Ballinger, 2011). Physically active older participants have been shown to have better static and dynamic postural control than sedentary age-matched individuals (Bulbulian & Hargan, 2000; Perrin, Gauchard, Perrot, & Jeandel, 1999). Indeed, various intervention studies including specific balance training (Clemson et al., 2010), strength training (Henwood & Taaffe, 2006), walking (Brooke-Wavell, Athersmith, Jones, & Masud, 1998), vibration platform training (Cheung et al., 2007), square stepping (Shigematsu et al., 2002), and Tai Chi (Taylor-Piliae et al., 2010) have all been found to improve static postural stability in healthy older adults. Notwithstanding the success of these interventions, the most recent Cochrane review on exercise for improving postural stability in older people highlighted the need to examine further the effects of different forms of physical activity on postural stability in an attempt to strengthen the currently weak evidence (Howe et al., 2011).

Group exercise is one of the most popular physical activities among middle-aged and older adults (Hunt, Ford, & and Mutrie, 2001). In particular, social dancing is an activity that is practiced by middle-aged and older adults all over the world. The cultural resonance and social benefits that come with group dance make this an appealing activity for the older age group (Cooper & Thomas, 2002; Lima & Vieira, 2007; Wikstrom, 2004). Varying forms of dance interventions including Traditional Greek, Caribbean, Argentinian tango, Traditional Korean, Turkish Forlore and aerobic dance have shown to benefit both static and dynamic postural stability in older participants (Eyigor, Karapolat, Durmaz, Ibisoglu, & Cakir, 2009; Federici, Bellagamba, & Rocchi, 2005; Hackney, Kantorovich, & Earhart, 2007; Hopkins, Murrah, Hoeger, & Rhodes, 1990; Jeon, Choe, M,A, & Chae, 2000; Sofianidis, Hatzitaki, Douka, & Grouios, 2009). Less research is available on habituated older exercisers, however it has been reported that habituated older folk dancers and gymnasts have better dynamic postural stability than aged matched controls (Uusi-Rasi et al., 1999) likely due to the stresses placed on the neuromotor system.

Scottish country dance is a hugely popular activity in older individuals, not only in Scotland, but also in North America, Australia and New Zealand. Scottish country dance, like other traditional dance forms such as square dancing and folk dancing, articulates choreographed multidirectional movements incorporating many elements of neuromuscular control. It consists of a number of set dances in pairs and groups, with varying degrees of intensity. Participants perform various vertical and lateral movements, turning and spinning around in different directions to the rhythms of both slow and faster tempos, therefore continuously altering and stressing their postural stability.

Scottish country dance has recently been shown to be beneficial to functional ability of older individuals (Dewhurst, Nelson, Dougall, & Bampouras, in press). The aim of the present study was to compare the postural stability in Scottish country dancers and age-matched physically active controls. It is hypothesized that due to the challenging postural demands of Scottish country dance, the dance group will show better postural stability than the age-matched physically active group, while preventing an increased reliance on the visual system which is normally reported in older adults (Choy, Brauer, & Nitz, 2003; Dewhurst, Riches, & De Vito, 2007). Women are the focus of the present study as it has been reported that women tend to fall more often (Schultz, Ashton-Miller, & Alexander, 1997) and have twice the rate of hip fracture than men (Kannus et al., 1999).

Methods

Participants

Fifty three healthy older females participated in the study after providing written informed consent. The sample consisted of Scottish country dancers (*n* = 20, age 67.9 ± 5.9 (range 60 - 79) years, , body mass 67.2 ± 9.1 kg, stature 1.61 ± 0.06 m) and controls (*n* = 33, age 71.1 ± 5.7 (range 62 - 79) years, body mass 65.0 ± 10.6 kg, stature 1.57 ± 0.07 m). Participants had no known neuromuscular disorders and had to be considered as medically stable, according to the criteria described by Greig et al (1994). All participants were physically active, engaging in some form of physical activity at least three times a week. The dancers had a minimum of 10 years participatory involvement in Scottish country dancing. Ethical approval was obtained from the University of Strathclyde and all procedures followed were in accordance with the Helsinki Declaration of 1975.

Physical activity assessment

Current levels of physical activity were measured using the Rapid Assessment of Physical Activity (RAPA) scale which is an easy-to-use, valid measure of physical activity for use with older adults (Topolski et al., 2006). This scale consists of 9 tick box responses relating to level and intensity of usual physical activity, as well as additional strength and flexibility activities. RAPA 1 measures cardio-respiratory based physical activity (scoring 1-7 points, with a maximum score of 7), RAPA 2a and 2b measures strength- and flexibility-based physical activity, respectively (yes/ no answer).

Static postural stability assessment

Participants performed the Romberg (standing feet together with arms resting by the side of the body) and the Tandem (feet are aligned heel to toe with the dominant foot at the back) tests standing barefoot and centrally aligned on a force platform (AMTI OR6-6; Advanced Mechanical Technology, Inc., Watertown, Massachusetts). Trials were performed under two visual conditions, eyes open (EO) and eyes closed (EC), administered in a randomised order, and each position was maintained for 35 s with the first 5 s discarded. Two minutes rest was given between trials. If participants lost their balance during a trial, they were allowed to repeat. A successful trial was one in which the subject did not move her feet or, in the case of the EC trials, open their eyes while standing on the platform during the assessment period. A maximum of three attempts were given per trial. During the EO trials, subjects had to focus on a visual target placed two meters in front of the subjects at eye level; participants were allowed to wear spectacles, if required.

Data were obtained from the force platform with a sampling frequency of 100 Hz (NetForce, Advanced Mechanical Technology, Inc., Watertown, Massachusetts) and centre of pressure (CoP) based time domain parameters were calculated (BioAnalysis, Advanced Mechanical Technology, Inc., Watertown, Massachusetts). 95% ellipse area (sway area) indicates the amount of CoP movement and is a method used to estimate the confidence area of the CoP path where approximately 95% of the points on the COP path are enclosed in. Sway velocity indicates the speed at which CoP adjustments are made. Both measurements have been used extensively to assess postural balance in older individuals (Brooke-Wavell et al., 1998; Dewhurst et al., 2007; Prieto, Myklebust, Hoffmann, Lovett, & Myklebust, 1996). Finally, in order to assess the influence of vision on the CoP parameters, the Romberg quotient and Tandem quotient were calculated as the ratio of the eyes closed value to the eyes open value for the sway area.

Statistical analysis

Current levels of physical activity, strength and flexibility exercise participation scores taken from the RAPA scale were analysed using chi-square. Normality of data of the CoP parameters was examined using the Kolmogorov-Smirnov test. As normality was not confirmed for all variables, non-parametric tests were utilized for the analysis. Subsequently, Spearman's correlation was used to examine for relationships between age and sway area or sway velocity and the Mann-Whitney U test was used to examine for differences between dancers and controls. When differences between dancers and controls were revealed, non-parametric effect sizes (ES) were calculated with 0.1 denoting a small effect, 0.3 a medium effect and 0.5 a large effect (Grissom and Kim, 2011). Significance was set at 0.05. For all statistical analyses, IBM SPSS v 19.0 (SPSS, Chicago, ILL) was used.

Results

Physical activity assessment

The quantification of physical activity showed the median score for the cardio-respiratory based physical activity for both groups being 6 on the RAPA scale: "I do 30 minutes or more a day of moderate physical activities, 5 or more days a week". The two groups were not significantly different in participating in strength training ($\chi^2 < 0.05$, 15% for both groups) but the controls participated in flexibility training more than the dancers ($\chi^2 < 0.05$, 61% and 43%, respectively).

Static stability postural assessment

Completion rates per group for each test can be found in Table 1. The age of the groups was not significantly different (U = 229, p = 0.63). No significant correlation was found for age with Romberg EC and Tandem EC sway area. Further no significant correlation was found for age with Tandem EO sway velocity. Finally, although significant correlations were found for age with Romberg EO and Tandem EO sway area as well as Romberg EO, Romberg EC and Tandem EC sway velocity they were all low (Spearman's ρ range: 0.317 – 0.392).

Sway area was the same for dancers and controls in all of the postural assessments (Figure 1A and B). Sway velocity was greater in controls than dancers in the Romberg EO (U = 63, p = 0.001, ES = 0.11), Romberg EC (U = 113, p = 0.001, ES = 0.21) and Tandem EO (U = 146, p = 0.003, ES = 0.25) but not Tandem EC. Finally, neither Romberg quotient nor Tandem quotient were affected by the participation in dance (Figure 2).

INSERT FIGURE 1 HERE

INSERT FIGURE 2 HERE

Discussion

The main finding of the present study was that although Scottish country dancers have similar sway area to physically active age-matched controls, an increased amount of regulatory activity may have been needed to maintain it compared to their physically active counterparts, as suggested by the difference in sway velocity.

Scottish country dance involves a combination of proprioceptively challenging moves including unipedal stance and hopping, while maintaining a straight posture with a constant shifting of the center of gravity. Additionally, the vestibular system is challenged during dances as multiple spinning actions are involved. Both the proprioceptive and vestibular systems are responsible for maintaining an upright posture (Dewhurst et al., 2007). It was hypothesized that the stimulation provided by Scottish country dance to the sensory systems and consequently the motor control systems will result in better postural stability when compared to non-dance physical activity participation. While no additional benefits of participation in Scottish country dance were shown for sway area when compared to physically active controls, it appears that mechanisms to achieving this sway area differ between the groups.

Sway velocity is related to the amount of activity needed in order to maintain a given level of postural stability (Prieto et al., 1996) and it is an important factor in maintaining postural control in quiet standing (Masani, Popovic, Nakazawa, Kouzaki, & Nozaki, 2003). Increased sway velocity has been linked with reduced balance ability in older individuals (Brooke-Wavell et al., 1998; Dewhurst et al., 2007; Prieto et al., 1996) and increased incidence of falls (Fernie, Gryfe, Holliday, & Llewellyn, 1982). The greater sway velocity of the control group in comparison to the dancers may suggest that more regulatory activity was needed to achieve the same level of sway area, suggesting poorer postural control.

The maintenance of a quiet upright stance involves a complex integration of the sensory systems (somatosensory, visual and vestibular), the motor system and a central integrating control system (Horak & MacPherson, 1996). The lower sway velocity in the dancers could be a consequence of a more sensitive sensory input and/or a superior motor response system. As mentioned previously, the vestibular and proprioceptive senses would be continually stressed during the Scottish country dance routines; this in turn may have delayed or reduced the age associated decline in the sensitivity of the mechanoreceptors within the vestibular apparatus and proprioceptors within the joints, tendons and muscles to a greater extent than less dynamic physical activities. In addition, Scottish country dance has been shown to benefit functional motor tasks such as walking speed and 8 foot up and go (Dewhurst et al. in press). This beneficial effect on the motor system may translate to a better regulative motor response. As regular physical activity in older individuals has been found to develop or maintain the efficiency of the reflexes involved in postural control (Gauchard, Gangloff, Jeandel, &Perrin 2003), we propose that it is possible that the nature of Scottish country dance further develops or maintains these reflexes.

The ratio between eyes closed to eyes open sway area assesses reliance on the visual system, with an increased ratio suggesting larger reliance on vision (Choy et al., 2003; Dewhurst et al., 2007). When comparing physically active older individuals to sedentary controls, Perrin et al (1999) reported that active individuals relied less on vision during both static and dynamic postural stability tasks. Further, dance has been shown to strengthen the accuracy of proprioceptive inputs and shift sensorimotor dominance from vision to proprioception during a dynamic postural task (Golomer, Cremieux, Dupui, Isableu, & Ohlmann, 1999) however, in the present study the eyes open to eyes closed ratio did not differ between the groups for either the Romberg or the Tandem tests.

The lack of a strong relationship between age and postural stability measures reported here may appear contradictory to literature, as static postural stability has been extensively reported to reduce with increased age (e.g. Browne, O'Hare, Finn, & Colin, 2002; Dewhurst et al., 2007; Prieto et al., 1996;). However, although studies have used older subjects of similar characteristics to the present study, the comparisons made are with young counterparts, rather than within the older individuals' age range. This only provides a limited picture as to how balance degrades over years. Baloh et al (1998) reported that in a 3-year follow up of 79-91 year olds, dynamic sway velocity increased annually. However, the age of the participants is outside the age range used in the present study. A comparison of balance in 60-70 and 70-80 year old participants showed a trend for decreased balance with increasing age (Steffen, Hacker, & Mollinger, 2002), however this contradicted a previous study which, similar to our findings, reported little relationship of age to balance (Bogle Thorbahn & Newton, 1996). Given the importance of balance in this specific population, we concur with the call by Steffen et al (2002) for more work in the area with appropriate sample sizes that will allow norms to be established.

Static postural stability has been extensively used as a measure of balance in older individuals (Amiridis, Arabatzi, Violaris, Stavropoulos & Hatzitaki, 2005; Dewhurst et al., 2007; Prieto et al., 1996). However, dynamic postural assessment has also been shown to be a sensitive measure in detecting the effect of aging on postural stability (Baloh, Fife, Zwerling, Socotch, Jacobson et al., 1994). Given the dynamic nature of Scottish country dance, dynamic postural assessment may have been more suited to detecting differences between Scottish country dancers and other physically active individuals. Dynamic postural control should be assessed in future works along with fall frequency in dancers compared to other physically active individuals.

Bulbulian and Hargan (2000) and Perrin et al. (1999) highlighted the importance of physical activity for postural stability, reporting that physically active older individuals had better postural stability than inactive controls, with suggestions of a dose response both with the length of engagement in physical activity (Bulbulian & Hargan, 2000; Perrin et al., 1999) as well as the quantity of physical activity (Brooke-Wavell et al., 1998). The present study posits that it is possible to maintain postural stability in older adults not only through general physical activity but also through more specific activities such as Scottish country dance.

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Table legend

Table 1. Completion rates (in percentages) per group for each static postural assessment. EO, eyes open; EC, eyes closed.

Table

	Sway area				Sway velocity			
	Romberg EO	Romberg EC	Tandem EO	Tandem EC	Romberg EO	Romberg EC	Tandem EO	Tandem EC
Controls	94	97	94	82	91	97	94	76
Dancers	95	100	90	70	95	85	95	70

Figure Legends

Figure 1. Posturography parameters during the Romberg and Tandem assessment: 95% Ellipse Area Romberg (A), 95% Ellipse Area Tandem (B), Sway Velocity Romberg (C), Sway Velocity Tandem (D) for the eyes open (Romberg (REO) and Tandem (TEO)) and eyes closed (Romberg (REC) and Tandem (TEC)) trials. Both dancers (open bars) and control groups (filled bars) are shown.

* denotes significant difference between the dancers and control groups ($p < 0.01$). Data are presented as mean ± standard error.

Figure 2. 95% Ellipse Area Quotient (eyes closed/ eyes open). Romberg quotient (RQ) and Tandem quotient (TQ) are displayed for the dancers (open bars) and control groups (filled bars). Data are presented as mean ± standard error.

Figures

Figure 1.

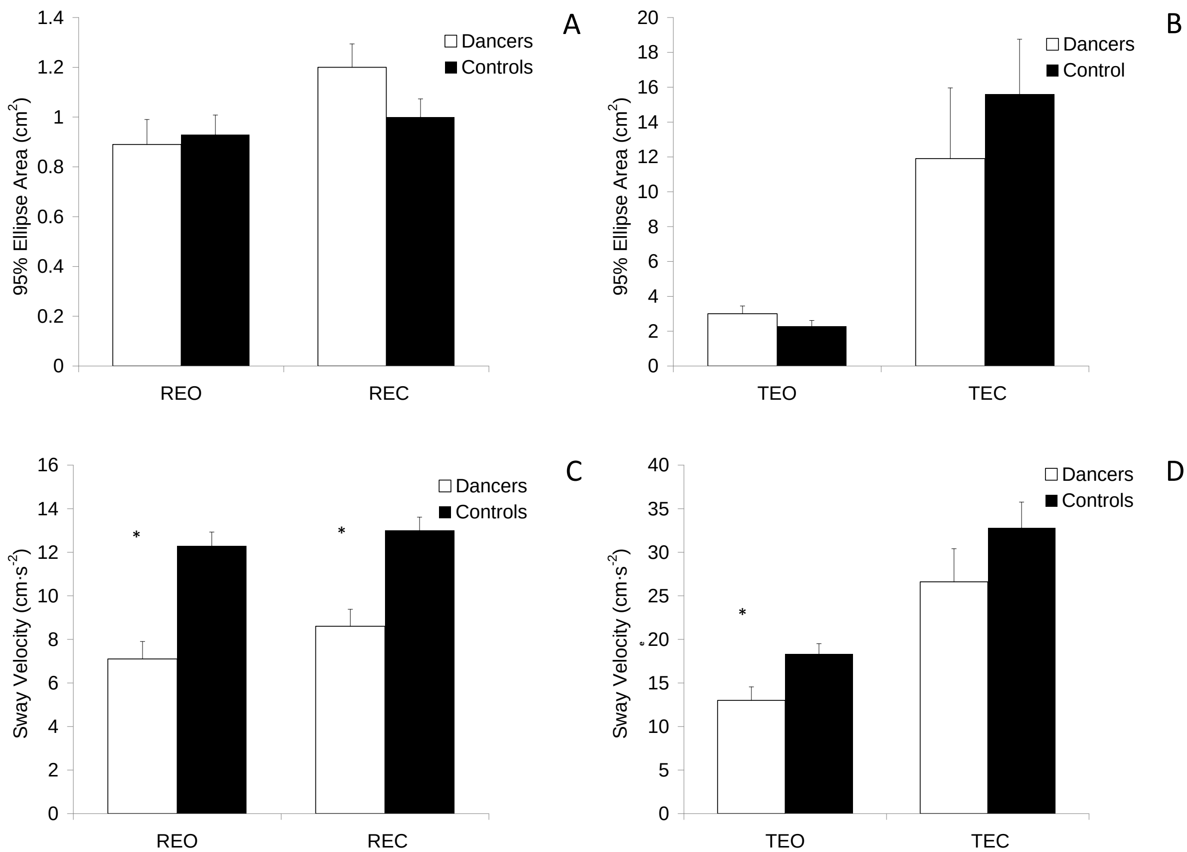
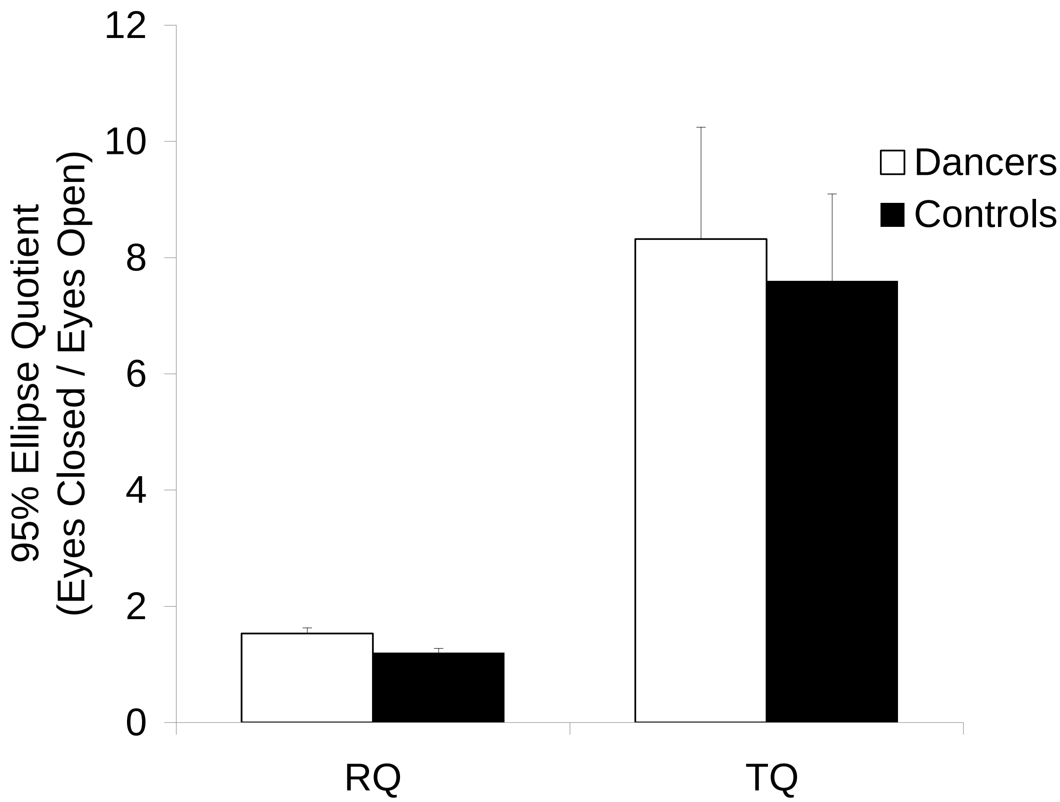


Figure 2


12
10
8
6
4
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0
95% Ellipse Quotient
(Eyes Closed / Eyes Open)
Dancers
Controls
RQ
TQ