The effect of dance on risk factors associated with falls in older adults

Abstract

Background: Falls in the UK's ageing population is a serious health concern that must be addressed. Exercise can reduce risk factors that increase older adults' risk of falls, such as deficits in balance, mobility and gait parameters. However, 28 % of adults aged 55-74 and 52 % aged 75+ remain inactive. Dance has been found to appeal to older adults as a fun form of exercise compared to standard forms, yet there is limited research to determine if dance can reduce risk factors. This study investigated the effect of a 12-week dance intervention on fall-related risk factors.

Methods: Twenty-one older adults (mean age = 78.0 ± 2.4 years; 19 females) completed one 60-minute mixed genre dance session per week for 12 weeks. Fall-related risk factors including balance and mobility (Timed Up and Go (TUG) time) and gait parameters (average double support (ADS) and average stride length (ASL)), were measured before (T1) and after (T2) the intervention by the Quantitative TUG test.

Results: TUG time and ADS decreased from T1 (15.35 ± 1.28 seconds; 29.33 ± 1.76 %) to T2 (13.51 ± 1.30 seconds; 25.33 ± 2.42 %; $P < 0.05$). ADS was the greatest individual predictor for the improvement in the TUG time ($B = -2.916$, $P = 0.714$).

Conclusions: A mixed genre dance programme can improve some, but not all, modifiable risk factors that increase older adults' risk of falling. Future work must include a control group and larger sample sizes to confirm the results.

Key words: Dance, Older Adults, Falls, Prevention, Balance, Gait.

Introduction

The UK population is ageing rapidly; in 2019, 16.2 million people were aged 60 years and above, this is projected to increase to 19.8 million people within the next 10 years (Foresight, 2019). Aging populations have considerable implications for society, as adults aged over 60 have a higher risk of falling, which is defined as an event in which an individual unintentionally loses balance and comes to rest at a lower position (World Health Organization, 2018). For example, 30 % of adults aged over 65 and 50 % of adults aged over 70, fall at least once a year (National Institute of Clinical Evidence, 2013). This can lead to a loss of independence, confidence, physical functioning, quality of life and can increase the risk of premature death by 10 % (Age UK, 2013). Falls also place pressure on the UK's National Health Service (NHS), with over two billion pounds a year spent on treating falls (Public Health Matters, 2014). Therefore, falls in the UK's aging population is a serious health concern that must be addressed.

Identifying modifiable risk factors that increase an older adults' risk of falling, is key for effective preventative programmes to reduce the risk of falls (Rubenstein & Josephson, 2003). Half of all falls amongst older adults occur during walking, due to deficits in balance and mobility (Verghese et al., 2009; Mertz et al., 2011). This is partly owing to a 10 % reduction in strength per decade, after the age of 30 (World Health Organization, 2004). Balance and mobility can be assessed by the Timed Up and Go (TUG) test (Podsiadlo & Richardson, 1991). It is also a recommended test by the American and British Geriatric Societies to categorise older adults falls risk, into either high or low risk (Barry et al., 2014). The test times how long it takes participants to stand up from a chair, walk three meters, turn around, return to the chair and sit down as quickly and safely as possible (Podsiadlo & Richardson, 1991). A result of 13.5+ seconds is categorised as a high risk of falling (Podsiadlo & Richardson, 1991). However, measuring how long it takes to complete the TUG test, does not identify specific deficits in balance or mobility during walking that increases the likelihood of a fall (Smith et al., 2016).

Other researchers have instead used laboratory kinematic gait assessments to break down the gait cycle into spatial and temporal parameters, for further information on identifying modifiable risk factors. For example, Margues et al. (2018) compared gait kinematics in older adults with a history of falls, with control counterparts (no history of falls), using foot switches over a 14-metre distance. They found that older adults who had fallen, had a shorter stride length (SL; 102 ± 10 cm) and spent a longer time with both feet on the ground, known as double support (DS; 0.15 ± 0.08 seconds), when compared to non-fallers (116 ± 10 cm; 0.1 ± 0.04 seconds, respectively). Hill et al. (1999) used computerised footswitch systems over a 10m walkway in a laboratory and found that time in DS and gait symmetry, were most strongly associated with predicting falls (odds ratio = 1.13; 95 % confidence interval) in older women (~74 years). However, these methods are confined to the laboratory, require expensive equipment and are time intensive, which are not feasible for older adults based in the community (Smith et al., 2016). The Quantitative Timed Up and Go (QTUG), devised by Kinesis Health technologies, is a novel method of technology that uses portable wireless sensors (Kinesis Health Technologies, 2020). It can quantify spatial and temporal kinematic parameters (including SL and DS) in the community, during the TUG test (Kinesis Health Technologies, 2020). Thus, the QTUG provides an effective community-based method to assess the impact of preventative programmes at reducing fall-related risk factors (Smith et al., 2016).

Interventions to reduce falls and improve balance and mobility, have been strongly linked with exercise (Sherrington et al., 2011; Alpert et al., 2009). UK Chief Medical Officers (CMO; 2019) suggest that adults aged 65+, should engage in 150 minutes per week of moderate intensity aerobic exercise, that focuses on muscle strength, balance and flexibility. A systematic review of 20 studies reported that exercise that incorporated the CMO's recommendations, decreased falls by 22-58% (Cadore et al., 2013). Three of these studies also observed a 4-17 % improvement in balance and mobility, as measured by the TUG test, after older adults exercised two to three times per week for 12-24 weeks (Kim et al., 2012; Lustosa et al., 2011; Kenny et al., 2010). Studies which noted the greatest improvements (10-17 % decrease in TUG time) incorporated either resistance training or multi-component exercise (Kim et al., 2012; Lustosa et al., 2011). Conversely, the study that found the smallest improvement (~4 %), consisted of yoga and chair aerobics (Kenny et al., 2010).

There is also encouraging evidence to suggest that exercise can improve gait parameters, and therefore reduce the risk of falls. For example, Lee et al. (2014) observed that participants reduced the percentage of the gait cycle spent in DS by ~0.8 % after 10 weeks of Wii fit or traditional exercise. However, the evidence as to whether exercise can improve SL is conflicting. Cao et al. (2007) found that a 12-week combined exercise intervention decreased SL by ~7 cm, which increased the risk of falls. In contrast, other researchers found that eight weeks of either walking or combined exercise increased SL by ~3-11 cm and therefore decreased the risk of falls (Lord et al., 1996; Oh-Park et al., 2011). These results are difficult to compare as each study used different methodologies to measure gait parameters, such as force platforms, accelerometers and electronic walkways. Nevertheless, it is still encouraging that the majority of evidence suggests that exercise can improve gait parameters and thus, reduce the risk of falls. Despite these potential benefits, 48 % of older adults who participated in an exercise programme withdrew within six months of starting, and 28 % of adults aged 55-74 and 52 % aged 75+ remain inactive (Simek et al., 2012; Sport England, 2019). For older adults to participate and remain engaged in the programme and therefore gain the most health benefits, interventions must be fun, engaging and safe (Alpert et al., 2009; Resnick & Spellbring, 2000). Therefore, it is essential that interventions address these factors for fall reduction programs to have a long-term impact on reducing modifiable risk factors and incidence of falls.

Dance, defined as the artistry of moving the body and limbs to the rhythm of music, is a form of exercise that older adults may be more accustomed to due to its popularity in the early and mid-twentieth century (Borges et a., 2014; Judge, 2003). The evolving routines allowing progression throughout sessions, as well as the expressive nature, has been found to appeal to older adults as a fun form of exercise compared to standard forms (Alpert et al., 2009; Song et al., 2004). Further to this, dance is an effective method of exercise for improving balance and mobility (Kattenstroth et al., 2010; Ganz et al., 2007). For example, dance interventions that were 30-60 minutes in duration, two to three days per week for six to nine weeks found improvements in TUG time; a Thai traditional and a contemporary dance intervention both improved TUG time by ~2.2 seconds (Noopud et al., 2018; X), and square stepping and low impact dance improved it by ~1.2 seconds and ~1.3 seconds respectively (Pope et al., 2019; Teixeria et al., 2013). However, none of the aforementioned studies investigated if dancing could improve modifiable gait parameters or which areas of gait led to the improvements in TUG time. This is despite literature identifying that a shorter SL and increase in DS can increase the risk of falls (Margus et al., 2018; Hill et al., 1999). Nonetheless, these data still tentatively suggest that dancing is a promising method to improve balance and mobility.

Overall, the literature has shown that decreased balance and mobility, shorter SL and increased DS is associated with a greater risk of falling in older adults. Exercise can improve these falls related risk factors, but exercise programmes have high attrition rates. Individual genres of dance are more appealing to older adults and can combat the associated declines in balance and mobility. However, no dance study has incorporated a range of dance styles, investigated if dance can improve SL or DS, analysed which areas of gait account for the improvement in balance and mobility, or used the QTUG. Therefore, the primary aim of this study was to use the QTUG to examine the effect of a 12-week dance programme (using a range of genres of dance, including contemporary, jive, ballet) on balance and mobility (TUG time) and modifiable gait parameters (including DS and SL). The secondary aim was to determine which gait parameter (DS or SL) contributed most to the changes in balance and mobility. It was hypothesised that after the dance intervention, TUG time would decrease, DS would decrease and be responsible for the improvements in TUG time and SL would be longer.

Methods

Participants

Thirty-five participants (mean age = 77.0 ± 9.2 years; 32 females) from across six socioeconomically deprived areas of X were recruited by an opportunity sample (participant characteristics are presented in Table 1). To be included in the study, participants were required to understand and speak English, be able to attend weekly dance sessions in one of six pre-selected community centres and be aged 55 years or above. No exclusion criteria were applied, as the intervention could be adapted to the needs of all participants. Ethical approval was sought from the host institution and written informed consent was obtained prior to the study.

Study design

The study implemented a pre-and-post uncontrolled intervention with six independent samples. Participants were invited to attend one taster dance session within their local community centre, where they were informed about the study and invited to take part. During the second session (T1), baseline data were obtained and during the fourteenth session (T2), following 12 weeks of dance, post intervention data were obtained. At T1, demographic data were recorded via a questionnaire and at both T1 and T2, participants completed the QTUG test. This data was obtained at the end of the sessions and in the same room the dance was carried out. Attendance data was recorded at all sessions.

Table 1. *Individual characteristics of all participants.*

Participant	Age (years)	Gender (M/F)	Health Condition (Y/N)	No. of Falls in the 3-months prior to the intervention
01*	84	F	Y	.
02*	88	F	N	0
03*	87	F	Y	0
04*	87	F	N	0
05*	85	F	Y	0
06	75	F	Y	.
07*	89	F	Y	1
08	83	F	N	0
09	75	F	Y	0
10*	.	F	.	1
11	77	F	Y	0
12	75	F	Y	.
13*	88	F	N	1
14*	91	F	N	0
15*	57	M	Y	0
16*	55	M	N	0
17	86	F	Y	0
18	76	F	N	0
19*	66	F	N	0
20	79	M	Y	.
21*	72	F	N	0
22*	75	F	.	.
23	77	F	N	.
24	67	F	.	0
25	73	F	Y	0
26	85	F	N	0
27	70	F	N	0
28	77	F	Y	0
29*	69	F	Y	.
30*	71	F	PNTS	0
31*	80	F	PNTS	0
32*	87	F	Y	.
33*	66	F	Y	0
34*	87	F	N	0
35*	71	F	Y	0

Note: . = data not available; * = notes participants included in the analysis; M = Male; F = Female; Y = Yes; N = No; PNTS = Prefer Not to Say.

Apparatus and Procedures

The QTUG test (developed by Kinesis Health Technologies), was used to measure balance, mobility and gait parameters. Participants were instructed to sit on a chair and on the word "go", to stand up, walk three metres to a mark on the floor, turn around, walk back to the chair and sit down at a fast and comfortable pace (Podsiadlo & Richardson, 1991). An inertial sensor, (Shimmer - 2R attached to the midpoint of each anterior shank by straps), recorded movement using an inbuilt triaxial gyroscope and a triaxial accelerometer (102.4Hz) about the anatomical mediolateral axis throughout the test (Kinesis Health Technologies, 2020; Smith et al., 2016). This data was transferred by Bluetooth to a handheld tablet (Kinesis Health Technologies, 2020). Kinesis application software (Volume 3.1) on the tablet, analysed the data using an algorithm to produce a quantitative assessment of 65 gait parameters (Kinesis Health Technologies, 2019). Three parameters were selected for this study, based on previous literature which identified them as common fall-related risk factors (Margues et al., 2018; Hill et al., 1999). These included: (1) TUG time - defined as the total time that it took to complete the QTUG test, (2) average double support (ADS) - defined as the average proportion of the gait cycle spent with both feet in contact with the ground and (3) average stride length (ASL) - defined as the average stride length when completing the QTUG test (Kinesis Health Technologies, 2019). These parameters demonstrated excellent to moderate reliability (intra-class correlation coefficient > 0.40), when identifying falls risk in older adults (~74.1 years; Smith et al., 2016). No studies have assessed the tests validity.

Dance Intervention

The 12-week intervention involved a one-hour dance session each week. Sessions were delivered by dance artists, all of whom had experience working with older adults and received one day of standardised training. Each session was flexible and could be adapted to meet the requirements and preferences of each participant. Thus, all elements could be completed sitting down, standing up or a mixture of both. A range of genres of dance were incorporated throughout the intervention, including contemporary, jive, ballroom, salsa, ballet and tap. Each session followed a general structure that included three components (Figure 1).

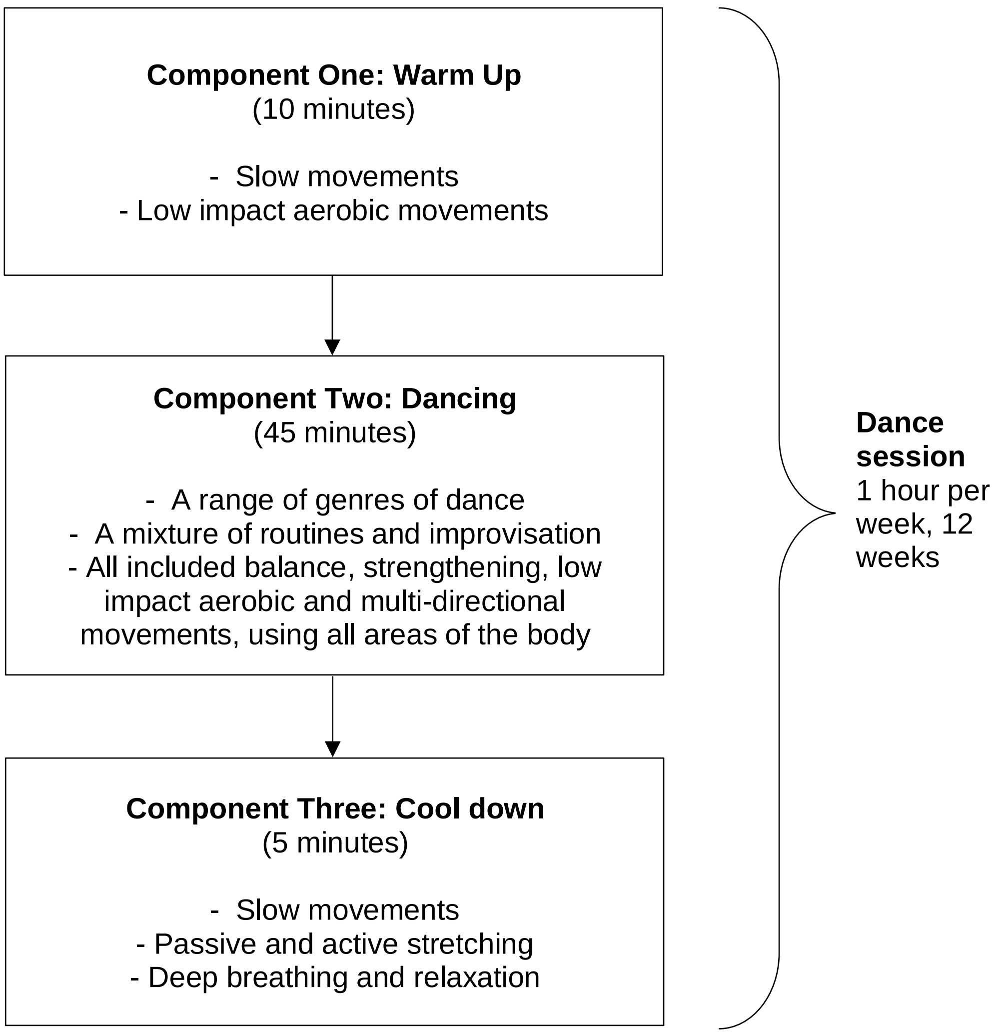

Figure 1. General structure of each dance session.

Data analysis

A descriptive statistical analysis (mean ± standard error) of participant characteristics was conducted to describe the sample. Mean adherence to the intervention was calculated by dividing the total number of sessions participants attended by the number of sessions offered during the intervention (n = 12). One participant was removed from the analysis as three outliers in their data (TUG time at T1 and T2, ADS at T2) were detected with mean values which were more than two standard deviations away from the group mean. Once removed, all data met the assumption of normality, as assessed by Shapiro-Wilk's test ($P > 0.05$). A paired samples t-test was used to determine changes in TUG time, ADS and ASL from T1 to T2. A multiple regression was used to determine how much of the variation in the time that it took to complete the TUG test from T1 to T2, could be explained by QTUG parameters as a whole and their individual contributions.

To do this, the difference between TUG time, ADS and ASL from T1 to T2 were calculated by T2 – T1 and new variables were created (TUG time difference, ADS difference and ASL difference), which were used in the analysis. A Pearson's product-moment correlation was then used to assess the relationship between TUG time difference and the greatest predictor of TUG time difference (ADS difference or ASL difference). The strength of the correlation (r) was considered either weak ($r < \pm 0.29$), moderate ($r = \pm 0.30–0.49$) or strong ($r > \pm 0.50$; Cohen, 1988). All data were analysed using IMB SPSS Statistics (version 26) software. An alpha level was accepted at $P < 0.05$ and all data was reported as mean ± standard error.

Results

Sample description and adherence rates

Thirty-five older adults were recruited for this study, 12 females and one male withdrew during the intervention due to unspecified reasons. A total of 22 older adults completed the intervention, and 21 older adults (mean age = 78.0 ± 2.4 years; 19 females) were included in the analysis (see Table 1). Adherence data were available for 14 participants, only. These participants had a mean adherence rate of 88.3 ± 0.3 %.

Response to the dance intervention

There was a statistically significant decrease in the time taken to complete the TUG test ($t_{(20)} = 2.95$, $P < 0.05$) from T1 (15.35 ± 1.28 seconds) to T2 (13.51 ± 1.30 seconds; Figure 2). The percentage of the gait cycle spent in ADS also significantly decreased ($t_{(20)} = 2.113$, $P < 0.05$) from T1 (29.33 ± 1.76 %) to T2 (25.33 ± 2.42 %; Figure 3). ASL was shorter from T1 (96.90 ± 4.44 cm) to T2 (95.56 ± 4.91 cm), but this did not reach statistical significance ($t_{(20)} = 0.253$, $P > 0.05$; Figure 4). The multiple regression revealed that 11.2 % variance in the time taken to complete the TUG test could be explained by changes in QTUG parameters as a whole. ADS difference was the greatest individual predictor of TUG time difference ($B = -2.916$, $P = 0.714$). The Pearson's product-moment correlation showed a weak negative correlation between ADS difference and TUG time difference ($r = -0.097$, $P = 0.338$; Figure 5).

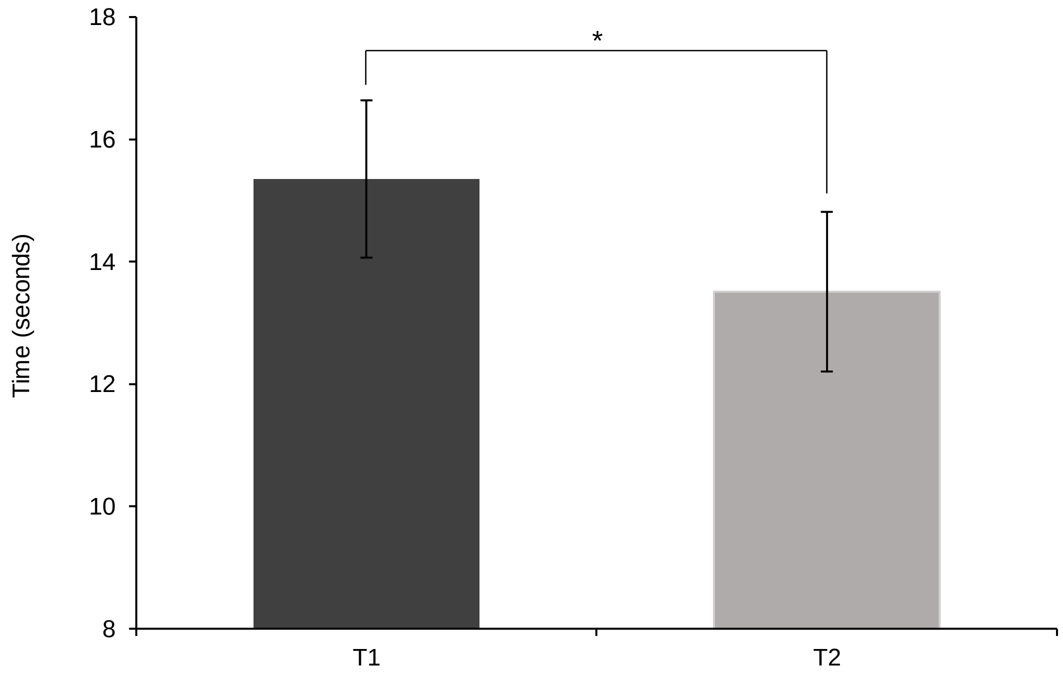

Figure 2. Mean (± standard error) time to complete the Quantitative Timed up and Go test pre (T1) and post (T2) the intervention (* denotes significance at P < 0.05).

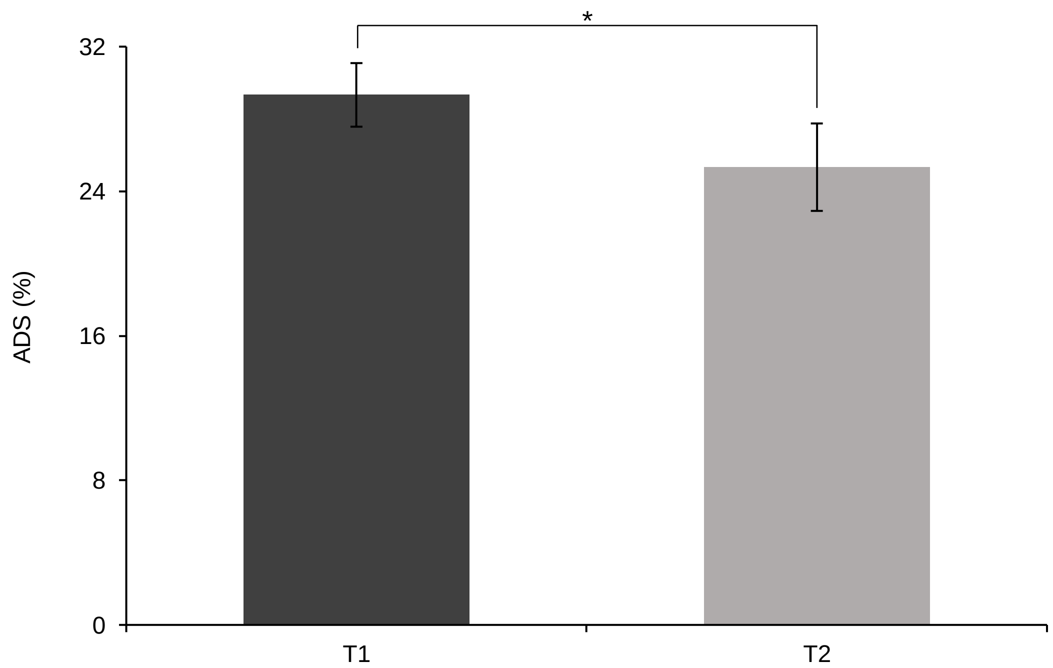

Figure 3. Mean (± standard error) percentage of the gait cycle participants spent in average double support (ADS) pre (T1) and post (T2) the intervention (* denotes significance at P < 0.05).

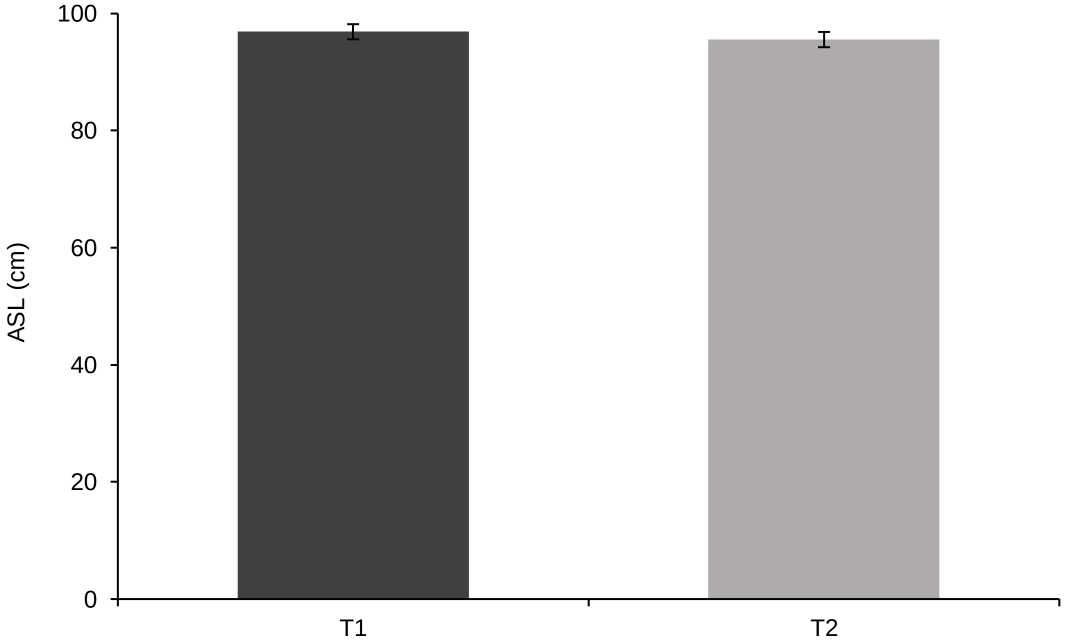

Figure 4. Mean (± standard error) average stride length pre (T1) and post (T2) the intervention.

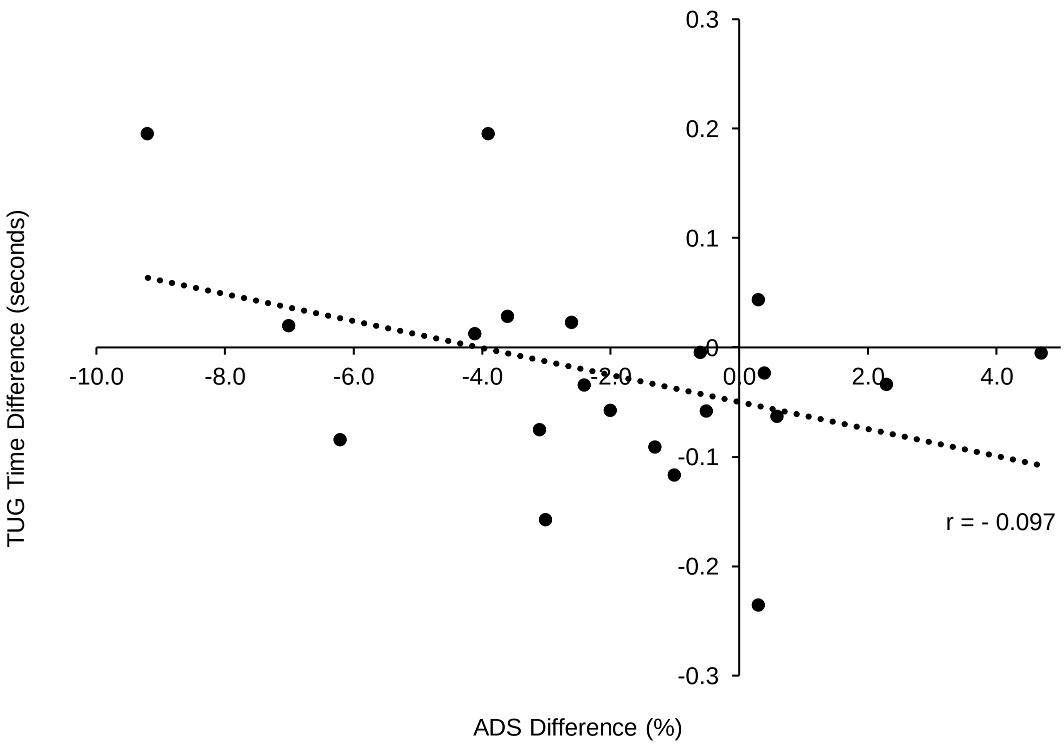

Figure 5. Correlation between Timed Up and Go (TUG) time difference and average double support (ADS) difference (r denotes the strength of the correlation).

Discussion

This was the first study to use the QTUG to determine the effect of a 12-week, mixed genre dance intervention on balance, mobility and gait parameters. This study also investigated which gait parameter led to changes in balance and mobility. The decrease in time to complete the QTUG test indicates that balance and mobility significantly improved. Dancing also significantly reduced ADS, which was greatest individual predictor for the improvements in balance and mobility. However, the beta value was low and there was a weak negative correlation between the changes in balance/mobility and the changes in ADS. In addition, the dance intervention did not improve all gait parameters, as ASL was non-significantly shorter after 12-weeks. Overall, this study indicated that a mixed genre dance intervention can significantly improve some, but not all, modifiable risk factors that increase the risk of falling in older adults. In addition, no strong conclusion could be drawn from the predictors of balance and mobility.

Balance and mobility improved after 12-weeks of dancing, as seen by the 1.84 ± 0.62 second reduction in TUG time. Notably, with 71 % of participants reducing their time. This improvement meant that participants reduced their falls risk categorisation from a high risk to the borderline of the low risk category as a result of the intervention (Podsiadlo & Richardson, 1991). This finding met the hypothesis that TUG time would decrease and was consistent with previous studies that reported TUG time decreased following exercise (~0.50-1.64 seconds) and dance interventions (~1.22-2.26 seconds; Noopud et al., 2018; X; Pope et al., 2019; Teixeria et al., 2013; Kenny et al., 2010; Lustosa et al., 2011). The significant improvements may be as a result of the common movements practiced when dancing, such as stepping and turning (X). Given that these movements are required to complete the QTUG test, it is likely that this element of the dance was responsible for the improvements in TUG time (Podsiadlo & Richardson, 1991). It should be noted that some participants were unable to complete all movements standing. Therefore, it was interesting that there was a significant improvement in TUG time. Whilst the mechanism for these improvements are unknown, it is plausible that the musculature of the lower-body was isometrically contracted to stabilise the upper-body when participants completed movements seated and thus, they still gained the benefits (Bozec et al., 2001; Gurfinkel et al., 1981).

Despite these interesting improvements, it could be argued that participants should have shown a greater improvement in TUG time when compared to other studies, based on differences at baseline. Participants in this study demonstrated a below average TUG time for their age at T1 (>10.20+ seconds; aged 70-79 years; Bohannon, 2006). It is expected that participants in this category should show the greatest improvements in TUG time as they are considered to have the greatest capacity for change (Cao et al., 2007). In contrast, participants in previous studies had a TUG time above or within normal values for their age at T1 (TUG time = 8.20-10.20 seconds; Bohannon, 2006; X; Kenny et al., 2010; Teixeria et al., 2013). Participants in a normal range, are expected to display small improvements only, as they are already at or close to their maximum performance (Bohannon, 2006; Cao et al., 2007). Given this, participants in this study should have show a greater improvement than participants in previous studies. However, this was not the case as participants in this study showed similar improvements (1.84 ± 0.62 second) to the aforementioned studies (~1.22-2.48 seconds). A possible explanation may be due to the characteristics of the intervention regime. This study's dance sessions took place once per week for 60 minutes. This was less than the UK CMO's (2019) recommendations of 150 minutes per week and less than previous interventions that were two days per week for 60-90 minutes per session (X; Noopud et a., 2018; Pope et al., 2019). Therefore, it could be suggested that 60 minutes per week of dancing was sufficient to improve TUG time but was not an adequate training dose to have the maximum effects on a sample with below average TUG at baseline. Consequently, future studies should expose participants to the intervention for longer than 60 minutes per week.

While the decreased TUG time indicated that balance and mobility improved, dancing also positively influenced fall-related gait parameters. Prior to the intervention, participants spent 29.33 ± 1.76 % of the gait cycle in ADS – similar to the gait pattern associated with falling (DS > 26 ± 30 %; Kwon et al., 2018). After the intervention, participants spent significantly less of the gait cycle in ADS (25.33 ± 2.42 %), with 71 % of participants reducing ADS. These results are closer to the gait pattern of non-fallers (DS < 24 ± 20 %; Kwon et al., 2018). Additionally, this met the hypothesis that stated DS would decrease and also indicated that participants were at a lower risk of falling. Although no other dance-related data exists, this finding is consistent with Lee et al. (2014), who found that 10 weeks of either strength, balance, walking or Wii-Sports exercise, decreased the percentage of the gait cycle spent in DS (T1 = 19.40 ± 3.20 %; T2 = 18.60 ± 4.20 %). The improvements in ADS may be due to the inclusion of balancing movements, especially those that involved single leg balancing. These movements were also completed by those who were mostly seeded during sessions, as they were encouraged to stand up, when possible, and use the backrest of the chair for support. Single leg balancing movements have similarities to the single support (SS) phase (i.e. where one limb is on contact with the ground), which participants spend a prolonged time in when DS is reduced (Kharb et al., 2011). These similarities include weight bearing on one leg, control over the body's centre of mass and the activation of lower limb and trunk muscles, all which aid postural control (Dieën et al., 2015; Kharb et al., 2011; Donath et al., 2016). As participants were able to practice single leg balancing and postural control is essential during walking, it is likely this could have aided participants in SS and led to the reduction in ADS (Kharb et al., 2011).

The change in ADS was the greatest individual predictor of the change in TUG time, which meets the hypothesis. Further analysis showed there was a weak negative correlation between these two variables. Although ADS was a greater predictor of TUG time than the other gait parameter measured (ASL), the beta value (B = -2.916) and weak correlation (r = -0.097) indicated that ADS was not a major contributor to TUG time. This indicates the involvement of other parameters that were not measured. As this was the first study to investigate this in order to understand the mechanism of how dancing improves balance and mobility, further work is needed to measure other gait parameters to identify the parameter that is the greatest predictor for the changes in TUG time. This will allow future interventions to be tailored to improve the particular parameter and thus, further improve balance and mobility.

The intervention did not improve all gait parameters. Participants showed a non-statistically significant shorter ASL between T1 (96.90 ± 4.44 cm) and T2 (95.56 ± 4.91 cm) and therefore rejects the study's hypothesis that SL would be longer. A short SL (< 102 ± 10 cm) is a gait characteristic commonly associated with falls, which indicates participants were at risk of a fall before and after the intervention (Margues et al., 2018). To the author's knowledge, no other studies have investigated the effect of dance interventions on SL. However, there are numerous exercise interventions which have, and the present study's findings are both consistent (Cao et al., 2007) and inconsistent with several studies (Oh-Park et al., 2011; Lord et al., 1996). For example, Cao et al. (2007) observed that SL was shorter but not statistically significantly different (T1 = 135 ± 18 cm; T2 = 128 ± 19 cm) after 12 weeks (two sessions per week for two hours each) of a combined walking, balancing and strengthening exercise intervention. Their participants did not share the same characteristics in SL at baseline (SL > 102 ± 10 cm) as this study but their findings demonstrated a similar trend in that the intervention did not improve SL and thus, did not reduce the falls risk. Conversely, Oh-Park et al. (2011) reported that SL was significantly longer (T1 = 100 ± 12 cm; T2 = 111 ± 10 cm) after eight weeks of treadmill training (three sessions per week). Their participants shared similar baseline characteristics to this study (SL < 102 ± 10 cm), yet the improvements indicated that SL was closer to that of non-fallers (SL > 116 ± 10 cm) after the intervention and thus, reduced their risk of falls (Margues et al., 2018).

The discrepancy between this study and the findings of Oh-Park et al. (2011) could be explained by the movements that were practised. Brach and VanSwearingen (2013) states that if the goal is to improve walking or SL, then it is essential that these movements are included in the intervention - known as task-oriented training. The treadmill walking intervention by Oh-Park et al. (2011) involved forwards movements only, which provided opportunities for specific SL training. In contrast, dancing involved multi-directional movements, with limited opportunities to step forwards multiple times to practise SL. As Oh-Park et al. (2011) study focused on walking forwards and this study did not, this likely explains the discrepancy in results and indicates that forwards movements must be incorporated into dance sessions more to improve SL. Although not measured, it is plausible that the multi-directional aspects in the dance intervention could result in improvements in participants' ability to change direction. Future work might wish to also assess older adults' gait during multiple planes of movement, rather than only when walking in a straight line.

Overall, this study improved two out of the three outcome measures. This provides evidence that a mixed genre dance intervention in the community, can reduce some risks factors associated with falling and thus, may decrease the incidence of falls in older adults. This will help them to maintain their independence, quality of life, physical functioning and consequently reduce the pressure on the NHS (Age UK, 2013). All of which, will positively impact participants health, society and the economy. The study's main strength was the use of the QTUG test. This allowed the author to examine the effect of dance on fall related gait parameters, which previous dance interventions have not studied. In addition, the QTUG test was time efficient, easy to administer and allowed data to be collected in the community - all of which were convenient for participants.

Despite this, the study has a number of limitations. Firstly, 91 % of the participants recruited were female, despite the study being offered to both genders (Table 1). This limits the generalisability of the findings to females only. Secondly, the effectiveness of this intervention was not evaluated against a control group. It cannot be concluded if the findings were due to the dance intervention or if other factors influenced the findings, such as activities participants engaged in outside of the intervention. Lastly, there was a large variance in the data that was consistent across all outcome measures at both T1 and T2, indicated by the large standard errors (Figure 2, 3 and 4). This variance was greater than previous studies (X; Lee et al., 2014; Oh-Park et al., 2011). The variance indicates that the pool of participants recruited were diverse in ability and responded to the dance differently. This was likely due to the lack of exclusion criteria and small sample size. Consequently, results may be skewed, and caution must be taken when interpreting the results. Future work needs to address these limitations. This must include investigating the barriers to males participating in dance and establishing methods to overcome them, in order for future interventions to appeal to both genders. The inclusion of a randomised control group to confirm the findings. Finally, larger sample sizes and screening of TUG time at baseline to exclude older adults at a low risk of falling, which will reduce the variance in the sample.

Conclusion

Findings from this study indicate that a mixed genre dance intervention improved balance, mobility and certain gait parameters including DS in older adults, as measured by the QTUG. However, it did not improve SL and no conclusion could be drawn as to what parameter was the greatest individual predictor for improvements in balance and mobility. Overall, this study provides evidence that a 12-week community mixed genre dance intervention for older adults, is an effective method to reduce some risk factors associated with falling.

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