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Effects of different weekly frequencies of dance on older adults' functional performance and physical activity patterns

Justin W.L. Keogh[1,2], Andrew Kilding[2,3], Philippa Pidgeon[3], Linda Ashley[3], Dawn Gillis[2]

[1] *Bond University Research Centre for Health, Exercise and Sports Sciences, Faculty of Health Sciences and Medicine, Bond University, Australia*
[2] *Centre for Physical Activity and Nutrition Research, AUT University, Auckland, New Zealand*
[3] *School of Sport and Recreation, AUT University, Auckland, New Zealand*

ABSTRACT

This study examined the effect of dancing on the functional performance and physical activity levels of 45 retirement village residents participating in either a control (n = 13), Once a Week (n = 18) or Twice a Week (n = 14) dance group for 12 weeks. Changes in functional performance were assessed by three functional tests (30 s bicep curl, Timed Up and Go and the Four Square Step Test) as well as the Late Life Function Index. The CHAMPS questionnaire was used to estimate the weekly total as well as moderate and greater intensity energy expenditure and associated frequency counts. Once a Week dancing resulted in significantly greater improvements in Four Square Step Test and estimated total energy expenditure than the control group; whereas the Twice a Week group significantly improved their Late Life Function Index (Total and Basic Lower Extremity) scores significantly more than the control group ($p<0.05$). No significant between-group differences were observed in the changes for the two dance groups ($p>0.05$). These results further support the belief that even once a week exercise (including dancing) can produce some significant benefits for older adults.

Keywords: aging; dancing; physical activity; physical function; retirement village.

INTRODUCTION

The aging process is typically associated with a number of changes that contribute to a reduction in the level of functional performance and physical activity levels of older adults. This has resulted in studies examining the benefits of various forms of physical activity in minimizing the prevalence and magnitude of this age-related decline. Research indicates that resistance training [1-3], Tai-Chi [4], dance [5], balance [6] and multi-modal training [7, 8] can all significantly improve various measures of functional performance in older adults. Some evidence also indicates exercise (perhaps mediated by these increase in functional performance) can significantly increase the level of habitual physical activity performed by older adults [9-11].

Current recommendations state that older adults must perform multiple bouts of exercise each week to obtain significant functional and health benefits [12]. Such a view would appear based on the results of studies that have shown that two or more exercise sessions per week are required for significant physical benefit in older adults [13-15]. However, several studies also indicate that one exercise session a week can also have significant benefits for older adults. For example, older adults can significantly increase their muscular strength, aerobic power and/or functional performance from one session per week of resistance training [16, 17], dance [18, 19] or combined resistance and aerobic training [20]. Such apparently equivocal findings indicate that the dose-response and the minimal exercise frequency (number of sessions per week) for older adults to obtain physical benefit are still somewhat unclear. Further studies examining the dose-response effect of exercise in older adults are needed to improve our understanding of the minimal training dosage required for an adaptation in older adults. Such

information is crucial as it is well known that time and cost are some of the primary barriers to increasing physical activity levels in older adults [21]. Therefore, if additional studies can demonstrate that once a week exercise is beneficial, it is likely that more older adults may exercise at least once a week and thus, gain some benefits.

Dance is a form of physical activity that particularly warrants attention as it involves many styles, is able to be performed in many physical environments and except for a suitable surface, does not require much expense or equipment [22]. Dance may be less threatening to older adults than other forms of exercise [23, 24] and assist them to remain connected to everyday life by encouraging fun and enjoyment, social interaction, a sense of community and an appreciation of aesthetics [24-26]. Therefore, dancing may be a form of physical activity that is more likely to be adopted as part of many older adults' lifestyles than other more structured and/or expensive exercise modes.

The dose-response and the minimal frequency of dance required for significant improvements in the functional performance and physical activity levels of older adults are currently unknown. Therefore, the aim of the present study was to compare the effects of 12 weeks of various frequencies (none, once or twice) of weekly dance classes on the functional performance and physical activity levels of older adults. It was hypothesized that both once and twice a week dancing would significantly increase older adults' functional performance and physical activity levels, but that these effects would be greater when dancing twice a week.

MATERIALS AND METHODS

Study Design

This study utilised a quasi-experimental cluster randomised controlled design to compare the potential benefits of none, one or two dance sessions per week on the functional performance and physical activity levels of older adults. Prospective falls data was also collected, via daily calendars during the study, in order to gain some preliminary data on the relative safety of dancing for older adults.

Participants

All participants were residents of retirement villages in the greater Auckland region of New Zealand with a minimum age of 70 years. Retirement villages are a common form of housing for adults over the age of 65 years in New Zealand and many other developed countries. Most retirement village residents live quite independently and therefore are quite different to residents of aged care facilities that have been described in other physical activity studies [18, 27]. Residents of these latter facilities are much more dependent on care staff for basic and instrumented activities of daily living than those recruited from the retirement villages in the present study.

The main inclusion criteria for entry into this study were that the participants had to state that they could walk unaided for several minutes, have no recent regular recent dance experience and no current injury or medical condition that might be made worse by participation in the project. Participants were pre-screened using a modified Physical Activity Readiness Questionnaire (PAR-Q). The PAR-Q is a self-screening tool that is commonly used by fitness centre staff to determine the relative safety or possible risk of exercising for new members based upon their responses to specific health history questions. These questions address focus on cardiovascular disease and symptoms, joint problems and medication used. While no PAR-Q score was calculated, any individuals who answered "Yes" to one or more questions were requested to gain medical clearance before enrolling in the study.

Approximately one third of the sample (i.e. those recruited from the first retirement village) was allocated to a control group and the participants from the remaining retirement villages allocated to the intervention groups. Each of the participants allocated to the intervention groups were able to select his/her preferred dance frequency (i.e. once or twice a week). While we acknowledge that such an approach is not as robust as a randomized controlled trial, this design was used as approximately half of the participants in each of the "intervention" retirement villages indicated that they would be unable to attend their two scheduled dance classes per week. The demographic characteristics of the three groups are presented in Table 1.

Table 1: Demographic characteristics of the three participant groups

	Control Group (n = 13)	Once a Week Group (n = 18)	Twice a Week Group (n = 14)	Between-Group P Value
Gender (F / M)	12 / 1	17 / 1	13 / 1	
Age (years)	76.5 ± 5.7	78.4 ± 5.8	79.9 ± 6.6	0.453
Height (cm)	156.7 ± 3.8	161.6 ± 8.1	157.8 ± 4.2	0.297
Mass (kg)	67.3 ± 13.2	62.6 ± 4.6	69.7 ± 10.1	0.162

All results are mean ± SD. F = female, M = male.

Dance Program

The dance style used was characterised as a modern or contemporary dance genre modified for the target age group [28, 29]. It involved a balance of repetition, variation and development of exercises that catered for the needs of the participants both as individuals and as a group over the 12 week program. The physical demands of the dance classes were gradually progressed, with the initial two weeks performed at a 'very light to 'light' intensity according to the 15 point (6-20) Borg rating of perceived exertion (RPE) scale. Over the following 10 weeks, the participants increased the intensity of their dance movements up to the 'somewhat hard' category. Similar to other recent studies [18, 30, 31], this was accomplished through small and gradual increases in physiological (e.g. duration, intensity etc.), biomechanical (e.g. increased centre of gravity excursion, bilateral to unilateral limb support, etc.) and expressive requirements of the movement vocabulary. Some structured creative dance exercises, based on individual interpretation of Rudolf Laban movement terminologies were included [28, 29, 32].

Each dance class consisted of warm-up, main dance and cool-down sections, with music used throughout most of these phases to increase enjoyment and aid in highlighting various movement dynamics [18]. The warm-up lasted for 5-10 minutes and involved gentle joint mobility, alignment, body awareness and weight transference activities, as well as opportunities for individual choice and expression. The main dance section consisted of increasingly complex dance movements that offered varied dynamic and expressive phrasing of the upper and lower body. These provided accumulative complexity e.g. awareness of space, directional change, and use of levels which were progressed from the warm-up and included partner dancing and social interaction. A variety of props such as scarves and hats were used to encourage a variety of artistic upper body movements, phrasing and coordination. The participants were also encouraged and guided to build a short dance phrase (combination of movements) to further add to the creative dance element and to provide an appropriate aesthetic final outcome to the classes [25, 32]. The cool-down lasted ~5 minutes and involved gentle movements of the major bodily joints as well as deep and slow inhalation and exhalation respiration cycles.

Procedures

At both the pre- and post-training testing sessions, all participants completed functional performance assessments and quantification of physical activity levels. These assessment sessions were conducted one week prior to the start of the intervention and within one week following the 12 week dance program, respectively. Falls statistics were also obtained during the study. All researchers were blinded to the allocation of the participants to the Once or Twice a Week dancing groups during all data collection assessment occasions.

Functional Performance Tests

Functional performance was assessed using three physical functional performance tests (Timed Up and Go - TUG; Four Square Step Test - FSST; 30 sec Sit to Stand - STS) and the LLFI questionnaire using standardized methods. The physical tests were used to assess varying objective aspects of older adults' functional performance, especially mobility and dynamic stability [33-35] and lower extremity muscular strength and endurance [36]. For the STS, each participant performed one practice trial of three repetitions followed by one maximal trial one minute later. For the TUG and FSST, one practice and two recorded trials were performed. One minute rest was given between trials for the TUG and two minutes rest for the FSST as the FSST requires greater time to complete than the TUG. Times were recorded using a digital hand-held stopwatch. For the tests where multiple trials were performed, the best (fastest) score was used for data analysis.

Timed Up and Go Test

The TUG test required each participant to rise from a chair, walk 3 m, turn around, and return to their starting (seated) position [35]. Each participant was instructed to complete the test "as quickly, but as safely as possible". The test-retest reliability of the TUG test in older adults has been reported as excellent with ICC = 0.98 [33].

Four Square Step Test

The FSST required participants to step over 4 pieces of foam (each ~ 1 m long) that were laid on the ground at 90° angles and secured by tape to each other (like a "plus" sign) [34]. Each participant started in a standing position in the bottom left square facing forward with their feet together. Participants were then required to move clockwise around the "plus" sign by moving forward, to the right, backward and then to the left so as to return to the starting square and from there to reverse their path so to finish at the starting position. Participants were instructed to "try to complete the sequence as fast and as safely as possible without touching the pieces of foam. Both feet must make contact with the floor in each square and if possible, face forward during the entire sequence" [34]. The test-retest reliability of the FSST has been reported as excellent (ICC = 0.93-0.99) [34].

30 sec Sit to Stand Test
For the STS test, each participant was asked to fully stand and sit down as many times as possible in 30 seconds from a chair (~43 cm high) that did not have any arm rests. The participant had their arms crossed at the wrist and held against the chest throughout the trial. The test-rests reliability of the 30 sec STS has been reported as very high-excellent with an ICC = 0.84-0.92 [36].

Late Life Function Index
The LLFI consists of 32 questions (using 5-point Likert scale) that examine older adults' perceptions on the degree of difficulty encountered when performing activities that could comprise aspects of their daily living. These questions comprised three dimensions: 1) upper extremity; 2) basic lower extremity; and 3) advanced lower extremity [37]. The LLFI has excellent test-retest reliability (ICC = 0.91-0.98) for the three dimensions and overall score [37, 38]. The validity of the LLFI is also high as the lower extremity scale scores correlate highly (r = 0.74-0.86) with the 10 item Physical Functioning Scale (PF-10), which has been considered the "gold standard" questionnaire for assessing functional performance in older adults. Compared to the PF-10, the LLFI has a wider range of content coverage, less ceiling effects and better relative precision across the spectrum of function [37].

Physical Activity Measures
The CHAMPS Physical Activity Questionnaire for Older Adults was used to assess participants' levels of physical activity by facilitating recall of participation in a variety of low to high-intensity physical activity performed during a typical week in the past four weeks [39, 40]. If participants reported doing any of the listed activities, they were asked to record the number of occasions the activity was normally performed per week and the average duration of that activity. A research assistant was available to assist the older adults completing the CHAMPS (as well as the LLFI) questionnaires if required, as such assistance was required in up to 25% of retirement village residents [41].

From the CHAMPS questionnaire, measures of total frequency per week and estimated weekly caloric expenditure were derived for all specified physical activities, as well as a subset including only activities at moderate or greater intensities (based on an assigned MET value ≥ 3.0). The test-retest reliability, measured across two weeks of the estimated CHAMPS caloric expenditure measures is quite good with an ICC = 0.62–0.76 [42]. The CHAMPS has also been shown to exhibit moderate effect size increases (ES = 0.38 – 0.64) in older adults as a result of physical activity programs [9].

Falls Rate
Some preliminary falls statistics were obtained during this study to determine if the dance program had any effect on falls rates. A fall was defined as "an unexpected event in which the participant comes to rest on the ground, floor or lower level" [43]. Falls data were obtained via prospective daily record and a notification system involving monthly reporting of falls to the investigators [43]. Due to the short duration of this study and the small sample size, only the number of falls were calculated and reported.

Data Analysis and Statistics
A three group pre- and post-test design was used to examine the effect of dance frequency on the changes in the dependent variables (functional performance and physical activity). These analyses were all performed using the Pre-Post Parallel Groups Trial spreadsheets of Hopkins [44]. Prior to analysis, the functional performance scores were log transformed, the estimated energy expenditure scores were percentile transformed and the physical activity counts were root transformed to reduce non-uniformity of the data as recommended by Hopkins [44]. For all comparisons in which significant between-group differences were observed at baseline, the analyses were also adjusted by using the participants' baseline scores as a covariate [1]. The means and standard deviations presented in the Results are the back-transformed means of the respective log, percentile and root transformed data. The magnitude of effect was determined by calculating Cohen's effect size. Standardised changes of <0.20, <0.60, <1.2, <2.0 and >2.0 were interpreted as trivial, small, moderate, large and very large effects, respectively [45, 46]. For all effect sizes, 90% confidence limits were calculated and cited in the text where appropriate. Significance was set at $p < 0.05$ for all analyses.

RESULTS

There were no significant differences in the baseline scores between any of the three groups for the LLFI and CHAMPS physical activity measures (Tables 2 and 3). However, there were some significant inter-group differences in the three objective functional performance tests (Table 1). The Once a Week group scored significantly better than the control group at baseline for the TUG (p = 0.018, ES = -0.89 ± 0.60) and STS (p =

0.013, ES = 0.92 ± 0.59) tests. Similarly, the Twice a Week group scored significantly better than the control group at baseline for the FSST (p = 0.038, ES = -0.82 ± 0.64) and STS (p = 0.049, ES = 0.77 ± 0.64) tests.

A summary of the training-related changes in the functional performance and estimated physical activity measures for the three groups can be found in Tables 2-3, respectively. As indicated in Table 2, a number of significant between-group effects for the functional performance measures were observed. Specifically, the Once a Week group had a significantly greater improvement in FSST (p = 0.032, ES = -0.42 ± 0.32) than the control group. In addition, the Twice a Week group had a significantly greater improvement in the total (p = 0.042, ES = 0.73 ± 0.58) and basic lower extremity (p = 0.011, ES = 0.83 ± 0.51) LLFI scores and a non-significant, but moderately greater improvement in the upper extremity (p = 0.147, ES = 0.65 ± 0.74) LLFI scores than the control group. No significant differences were observed between the Once and Twice a Week groups for the changes in the functional performance scores (p = 0.355-0.949, ES = -0.18 ± 0.62 to 0.04 ± 0.44).

Table 2: Changes in the functional performance of the three participant groups

	Control Group (n = 13)			Once per Week Group (n =18)			Twice per Week Group (n = 14)		
	Pre-Test	Post-Test	Change	Pre-Test	Post-Test	Change	Pre-Test	Post-Test	Change
Physical Tests									
TUG (s)	9.84 ± 1.91	9.48 ± 2.41	-4%	8.31 ± 1.51	8.31 ± 1.42	0%	8.59 ± 1.85	8.56 ± 1.86	0%
FSST (s)	10.54 ± 1.89	10.33 ± 2.49	-2%	10.11 ± 1.87	8.94 ± 1.14*	-12%	8.99 ± 1.97	8.39 ± 1.50	-7%
STS (reps)	10.1 ± 2.1	10.5 ± 2.1	+5%	12.9 ± 3.9	13.0 ± 3.3	+1%	12.2 ± 3.1	12.6 ± 3.6	+3%
LLFI									
Total Function	60.2 ± 6.7	59.3 ± 7.0	-1%	59.1 ± 10.3	63.0 ± 9.0	+7%	54.5 ± 8.5	60.8 ± 8.1*	+12%
Upper Extremity	77.8 ± 10.7	76.7 ± 14.6	-1%	70.0 ± 16.1	76.2 ± 12.2	+9%	70.0 ± 15.4	78.8 ± 15.5†	+13%
Basic Lower Extr	76.2 ± 13.3	73.2 ± 10.8	-4%	69.7 ± 15.6	75.4 ± 14.0	+8%	66.0 ± 12.4	76.4 ± 14.2*	+16%
Adv Lower Extr	48.9 ± 13.0	48.1 ± 12.0	-2%	52.8 ± 12.8	56.3 ± 12.4	+7%	42.8 ± 11.9	50.5 ± 13.5	+18%

*All results are mean ±SD. TUG = Timed Up and Go test, FSST = Four Square Step test, STS = Sit to Stand test, s = seconds, reps = repetitions, LLFI = Late Life Function Index, Extr = Extremity, Adv = Advanced, Change = the within-group percent pre-post test change. A positive change in score is deemed beneficial for all outcome measures with the exception of the Timed Up and Go and Four Square Step Test. * Significantly greater (p < 0.05) improvement than the control group. † Non-significant but moderately (effect size > 0.60) greater improvement than the control group.*

As can be seen in Table 3, a number of significant between-group effects were observed for the physical activity measures. The Once a Week group had a significantly greater improvement in the estimated total energy expenditure (p = 0.028, ES = 1.28 ± 0.91) and a non-significant but moderately greater increase in the estimated moderate or greater intensity energy expenditure (p = 0.185, ES = 0.85 ± 1.09) than the control group. Although there were no significant differences between the Twice a Week and control groups in any of the measures of physical activity, there was a moderately greate-r increase in the estimated total energy expenditure (p = 0.092, ES = 0.67 ± 0.66) for the Twice a Week than the control group. No significant differences between the Once and Twice a Week groups were observed for the changes in the physical activity measures (p = 0.093-0.578, ES = -0.17 ± 0.50 to 0.60 ± 0.58).

Table 3: Changes in physical activity measures of the three participant groups obtained from the CHAMPS Physical Activity Questionnaire.

	Control Group (n = 13)			Once per Week Group (n =18)			Twice per Week Group (n = 14)		
	Pre-Test	Post-Test	Change	Pre-Test	Post-Test	Change	Pre-Test	Post-Test	Change
Est Total EE (kcal/wk)	1913 ± 977	1871 ± 1508	-2%	1922 ± 643	2910 ± 847*	+51%	2429 ± 1409	3618 ± 2989†	+49%
Est Mod or Greater Intensity EE (kcal/wk)	1206 ± 1045	1314 ± 1153	+9%	1027 ± 363	1632 ± 742†	+59%	1552 ± 1215	2327 ± 2696	+50%
Total Freq (counts)	25.7 ± 14.5	28.9 ± 15.2	+12%	25.4 ± 10.8	25.2 ± 10.8	-1%	32.5 ± 15.4	33.7 ± 13.1	+4%
Mod or Greater Intensity Freq (counts)	6.4 ± 7.1	7.4 ± 4.9	+16%	6.7 ± 5.0	5.7 ± 2.5	-15%	9.1 ± 7.7	9.0 ± 7.6	-1%

*All results are mean ±SD. Est = Estimated, EE = energy expenditure, Freq = frequency, Mod = moderate, kcal/wk = kilocalories/week, Change = the within-group percent pre-post test change. A positive change in score is deemed beneficial for all outcome measures. * Significantly greater (p < 0.05) improvement than the control group. † Non-significant but moderately (effect size > 0.60) greater improvement than the control group.*

Inspection of the falls data indicated a total of three falls for the control group, two falls for the Once a Week dance group and one fall for the Twice a Week group across the 12 weeks. None of these six falls were described as serious. Of the three falls that occurred in the intervention groups, one happened during a dance class.

DISCUSSION

The findings of the present study indicated that older adults obtained a number of significant benefits from 12 weeks of dancing. Specifically, significant increases in functional performance were found for the Once a Week group in an objectively measured mobility test (i.e. the FSST). Further, participants in the Twice a Week group reported significant improvements in their total and basic lower extremity function (as indicated by their LLFI component scores) as well as a moderate, albeit non-significant increase in upper extremity function. These significant increases in measures of functional performance were consistent with a recent review of the literature [5], in which dancing significantly improved older adults' functional performance in tasks requiring gait speed, agility and dynamic balance.

With respect to the functional performance measures used in the present study, no significant changes in performance were observed for the TUG or the STS tests. This was initially surprising as significant increases in older adults' TUG [18, 19] and STS [18] performance have been reported in previous dance studies, even those including only one dance class per week [19]. Inspection of the data revealed that the lack of change in these scores for the present study may have reflected differences in the baseline values. Comparison of baseline results revealed that the control group in the present study performed significantly worse in the TUG than the Once a Week group and significantly worse than both groups in the STS. Further, all participants in the present study (including the control group) performed substantially better than the participants of Holmerová et al. [18] and Young et al. [19] in the TUG by about 1.5-4 s and in the STS by ~5 repetitions. Thus, the lack of any significant change in the older adults' STS and TUG performance for the two dance groups in the current study may have reflected the fact that they already possessed quite high levels of ability in these tests at baseline.

A significant improvement in FSST was observed for the Once a Week group over the 12 week training program. Unlike the TUG and STS which require movements in predominantly one direction, the FSST examines the ability of older adults to move quickly and precisely in anterior, lateral and posterior directions. As the dance programme incorporated movements in all of these three directions, it may be that the principle of specificity applied here, whereby the greater similarity of movements performed in the dance classes resulted in significant improvements in FSST but not the STS and TUG. Therefore, the lack of a significant improvement in FSST performance for the Twice a Week group was surprising. This may have however reflected the Twice a Week group's significantly better performance at baseline than the control group. Compared to the literature, the Twice a Week group also had mean scores approaching that of Non-fallers [34], but substantially better than Multiple-fallers [34], older stroke patients [47] and older adults with vestibular disorders [48]. This would suggest that the participants in the Twice a Week group were already quite well functioning in terms of their FSST ability and may have had relatively little potential for improvement in this test.

The significant increase in total and basic lower extremity components of the LLFI, along with a non-significant but moderate increase in upper extremity LLFI performance for the Twice a Week group were also important findings. The LLFI assessed the older adults' perceptions of the degree of difficulty they encountered performing a variety of activities of daily living. Thus, significant increases in these scores indicate that the older adults felt that the dance program allowed them to more easily perform a range of activities of daily living that involved the upper and lower body. The magnitude of these improvements (as assessed by effect size analyses) were moderate, with the net effect of this improvement resulting in their group's mean score changing from "Moderate Functional Limitations" to "Slight Functional Limitations" [38]. The moderate, although non-significant increase in the upper limb LLFI component was also of interest, as only two dance studies involving older adults have measured changes in upper limb function [49, 50], although this was limited to upper limb muscular strength for both studies. It would therefore appear prudent for more dance studies to examine changes in the upper body function of older adults using assessments that are more related to common activities of daily living. Results of the present study may also encourage dance practitioners and researchers to include more expressive upper body movements within their dance classes for older adults in an attempt to further improve aspects of upper body function.

Analysis of the CHAMPS physical activity questionnaire data indicated a significant increase in the estimated total energy expenditure for all specified activities for the Once a Week group, with a non-significant but moderate increase in estimated moderate or greater intensity energy expenditure also apparent. While there were no significant increases in estimated energy expenditure for the Twice a Week group, a moderate albeit insignificant increase in estimated total energy expenditure for all specified activities was observed. Such a result may be of

relevance as the Twice a Week group had a mean increase of ~1200 kcal/wk. This increase in estimated energy expenditure would likely be of health benefit for many older adults [51] and was somewhat greater than the significant increase in energy expenditure reported by Stewart et al. [39] in one of the original CHAMPS studies. The increased levels of energy expenditure post-intervention for the dance groups appears novel, with no other studies having examined this issue previously. These increases in weekly energy expenditure are particularly important due to the prevalence of obesity, metabolic syndrome and other chronic co-morbidities in older adults [12, 52, 53] and because many older adults may not perform sufficient physical activity for health benefits [53, 54].

It was also interesting to note that the CHAMPS data revealed no significant changes in the weekly frequency of the specified physical activities or the subset of moderate or greater intensity physical activities for the dance groups. This would mean that the increased estimated energy expenditure must have resulted from a greater duration and/or the intensity of individual exercise bouts.

In accordance with PROFANE guidelines [43], we used daily falls calendars to obtain prospective falls data during this study. Results indicated a small number (n = 6) of falls occurred during the 12 weeks of the study. As some prospective data suggests that 39% of adults over the age of 65 years experience at least one fall a year [55], six falls in 12 weeks would appear to be similar to that expected for a sample of 45 older adults over this time-frame. In the only other study to assess falls rates in older dancers, Jeon et al. [56] found significant reductions in falls rates for 130 older adults after 12 weeks of Korean traditional dancing. Based on the results of the present study and that of Jeon et al. [56] as well as perhaps the significant improvement in the falls efficacy scale reported by Hackney et al. [31], it would appear that older adult-specific dance classes are safe and either have no harmful effect or may actually reduce falls rates in this population. However, we acknowledge that further studies are needed to substantiate our preliminary observations.

It was interesting to observe no significant differences in response between the Once a Week and Twice a Week dance groups for any of the outcome measures. Such a result may be interpreted in one of two ways. The first is that there was a lack of statistical power to detect between-group differences in response. The second is that the Once and Twice a Week dance groups actually experienced similar dancing-related gains in functional performance and physical activity. Inspection of the within-group percentage change scores and the between-group effect sizes generally supports this second assertion, as the magnitude of these differences (with effect sizes being trivial to small) was not overly large. These results support previous research in which even one dance class [18, 19] or resistance training session [16, 17] a week significantly improved a number of measures of functional performance in older adults. As not all older individuals might be willing, or able, to devote enough time to attend dance classes on multiple days per week, public health messages for older adults should promote the message that even one exercise (dance) class per week may have some significant benefits.

We acknowledge some limitations of our study. The major limitation was that a quasi-experimental research approach was used, with the participants self-selecting the frequency of dance they performed each week. The primary issue with this design was the significant between-group differences at baseline for some of the objective measures of functional performance. Another limitation was that the study involved a relatively small sample size of 18, 14 and 13 participants in the Once a Week, Twice a Week and control groups, respectively. Such sample sizes may have limited the power of some of the statistical comparisons, particularly those for estimated energy expenditure in which there was relatively high within-group variation. However, the authors are aware of only three other dose-response studies involving older adults [14, 16, 17]. These three studies have involved sample sizes of 9-12 older adults per group, with the study of DiFrancisco-Donoghue et al. [17] also having no control group. As the sample sizes of these three studies are less than that of the present study, it would appear that our results add much to the literature. The other limitation was that we only compared Once and Twice a Week dancing, even though at least half of the older adult dance studies reviewed by Keogh et al. [5] involved three dance classes per week. We would therefore recommend that future studies in this area should be conducted using random allocation of participants, involve the recruitment of a greater sample size and compare the effect of one, two and three dance classes per week to better understand the dose-response of dancing in older adults.

Irrespective of its limitations, the results of this study add much to the burgeoning literature on the benefits of dance for the health and wellness of older adults [24, 31, 57]. Results of this study suggest that a number of physical benefits can be derived from even one dance class each week; a result that has major implications to those older adults who may only be able, or willing to dance once a week.

CONCLUSION

The results of this study further support the view that dance is a form of physical activity that can improve the functional performance and increase physical activity levels in older adults. Importantly, it would appear that some of these improvements can be observed in 12 weeks from as little as one dance class per week. This is a very important finding as not all older individuals may have the time or inclination to dance more than one day per week. In conjunction with the findings of studies involving other forms of exercise such as resistance training, the results of this study would suggest that public health messages should inform older adults that even one dance session per week may be enough to obtain some significant improvements in functional performance and increases in physical activity. Future research in this area should also investigate the potential for once a week dancing to provide psychosocial benefits for older adults.

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