The Role of "Non-Traditional" Physical Activities in Improving Balance in Older Adults - A Review

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Abstract

Recent research indicates that the number of people aged over 60 years is rising faster than any other age group which will put increased financial and social strains on all countries. One major focus of various health and social care agencies is not only to keep these older individuals healthy but also physically active and independent. Many older people lead inactive lives which together with the ageing process lead to physiological changes which have potentially damaging effects on balance control and are risk factors for falls. Research shows that physical activity improves mental health, often stimulates social contacts and can help older people remain as independent as possible. This paper has attempted to review existing research on physical activities and exercise intervention used to improve balance in older adults. Using relevant databases and keywords, 68 studies that met the inclusion criteria were reviewed. Results indicate that many traditional activities can help to improve balance in older adults. However, further investigations need to be conducted into activities that are not generally considered appropriate for older people but may be enjoyable and have health benefits and may help to improve balance in this population.

Keywords

Physical activity
Exercise
Older adults
Healthy ageing
Balance

Introduction

In almost every country, the proportion of people aged 60 years and over is growing faster than any other age group and although this population ageing is one of humanity's greatest triumphs, it is also one of our greatest challenges as it will put increased economic and social demands on all countries [65]. Participation in regular, moderate physical activity can delay functional declines and reduce the onset of chronic diseases in both healthy and chronically ill older people [65].

Physical activity is defined as any bodily movement produced by skeletal muscles that require energy expenditure and has a positive correlation with physical fitness. Active living improves mental health, often promotes social contacts and can help older people remain as independent as possible for the longest period of time. There is strong evidence showing that older adults who are physically active demonstrate many health benefits, one of which is a lower risk of falling. Medical costs are substantially lower, demonstrating important economic benefits when older people are physically active [65]. Contrary to this, physical inactivity has been identified as the fourth leading risk factor for global mortality.

Despite the benefits, high proportions of older people lead sedentary lives. Policies and programmes should encourage inactive people to become more active as they age and to provide them with opportunities to do so [65]. The American College of Sports Medicine (ACSM) suggests group-based programmes over individual programmes and the incorporation of behavioural-change principles as critical elements for initiating and maintaining physical activity in older adults [59].

Ageing leads to physiological changes including reduced muscle strength, joint range of motion, reaction time, and changes in sensory systems, all which have potentially damaging effects on older peoples balance control and have been identified as important risk factors for falls in older people [66]. This balance could be defined as the ability to maintain the projection of the body's centre of mass within limits of the base of support, as in standing or sitting, or in transit to a new base of support, as in walking [66].

Throughout the world, preventing falls is a public health challenge and as people are living longer, the health burden and the costs associated with falls are expected to rise [65]. Furthermore, in older adults, falls are a common cause of morbidity and mortality. Extensive studies have investigated the function of physical activity/exercise in relation to fall prevention, confirming that exercise is a successful, stand-alone strategy for fall prevention for the general population and for high risk individuals [51]. Exercise interventions for fall prevention in community dwelling older adults should therefore include balance, gait and strength training.

Recommendations from the American College of Sports Medicine and the American Heart Association to promote and maintain health in older adults is for moderate-intensity aerobic physical activity for a minimum of 30 minutes on five days each week or vigorous-intensity aerobic activity for a minimum of 20 minutes on three days of the week [67]. It is recommended that to reduce the risk of injury from falls, community dwelling older adults should perform exercises that maintain or improve balance on at least two days a week and balance training of at least 120 minutes per week is considered as best practice for fall prevention [50]. As much of the research has focused on specific balance exercises rather than activities which may promote balance (e.g. varieties of dancing, ice-skating), balance exercises have typically been recommended, although preferred types, frequency and duration of balance training are unclear and not specified in the clinical guidelines. Merom et al [39] found that participation in falls prevention specific exercise to be low. Therefore, innovative approaches to exercise, allowing individuals to make healthy choices and giving communities the equipment to tackle their own particular exercise/physical activity needs are required. The purpose of this paper is to review existing research on balance enhancing physical activities and exercise interventions in older, healthy adults, aged 60 years plus. Any physical activity/type of exercise can be included, with the main goal of the activity intervention being to demonstrate an improvement in health, concentrating on that of enhanced balance. Following the review of the papers, the authors will propose another different, non-traditional activity to be researched to potentially improve balance in older adults.

Methodology

Initial searches were conducted in the electronic database Pubmed, first using the keywords 'physical activity' AND 'exercise' AND 'healthy ageing' AND 'balance'. A further search was performed replacing healthy ageing with 'older adults'. The search was limited to English Language, and publication dates of 1970 to present were set. Inclusion criteria comprised of subjects being 60 years of age and over and in good health with no medical complications. Exercise/physical activity had to be included as an intervention, with improvement in health, concentrating on balance as an outcome. Papers were excluded if the subjects were younger than 60 years of age and presented with any medical complications. These searches were supplemented by tracking all key references from the appropriate articles identified. A narrative literature review methodology was employed. This was deemed most appropriate as it allows for a comprehensive overview of the review topic to be produced as opposed to other methods, such as systematic reviews, which focus on a specific question.

Results

After the usual iteration process of identifying the manuscripts using the title and abstract and then by reviewing the full papers, a total of 68 papers were identified that included healthy participants aged 60 years and over, exercise/physical activity as an intervention and improvement in health, concentrating on balance, as an outcome. The type of activity and the way in which it was delivered was examined, together with the influence of the activity on the subjects.

Methods of delivering physical activity

It is important to be able to encourage individuals to participate in physical activities in many different ways. Being able to incorporate the activities into everyday life may be more beneficial to some individuals, whereas others may wish to pursue an activity in a different setting. The interventions in many studies are carried out in a variety of settings; at home, in rehabilitation centres, gyms and community centres. They are delivered using different methods; individually written programmes by physical therapists, home based interventions, group interventions and exercise classes. They are also

performed for different amounts of time, from 2-3 sessions for 4-6 weeks to 5 sessions per week for 6 months.

Home based exercise programmes may be more appropriate for some adults and have been used effectively when investigating outcomes on balance improvement. Personalised programmes developed by experienced physical therapists have been examined using balance and strength exercises, together with tailored walking programmes, exercises sitting, standing and walking and balance training during daily activities [66, 64].

Bates, Eccleston and Kershaw [3] evaluated a home-based strength and balance exercise programme for older adults, revealing improvements in strength and balance and a reduction in falls. Participants attended a two hour workshop where physiotherapists taught the exercises. They were initially given a manual (with diagrams of the exercises), ankle weight, pedometer, Heartmoves DVD, study calendar, a book 'Staying Power' and were asked to complete the balance and strength exercises three times a week and to walk twice a week. Participants were to record on their calendar when they completed the exercises, walked, used the DVD or had a fall. A second workshop was held at week 12 where exercise technique was checked by physiotherapists with participants having the opportunity to discuss any problems with the exercises. In conclusion, the programme appears to be successful in improving strength and balance in people aged 60 years who live in the community. The provision of a home-based exercise program may assist people in reaching the recommended dose of balance exercise for preventing falls. It is recommended that the programme is implemented with an older age group with a falls risk and a control group, with further research required to determine long term adherence to the programme at home and whether the programme can reduce falls in older people.

Yang et al. [66] investigated the effectiveness of a personalized home-based exercise programme in reversing older people's mild balance dysfunction using a sample of ambulant community dwelling adults aged 65 and over, who required no walking aid or used a single point stick only. These participants experienced no more than one fall in the previous 12 months before participating in the experiments but had concerns regarding balance. The personalized home exercise programme of balance and strength

training significantly improved performance on balance related measures in older people with mild balance dysfunction.

Gardner, Buchner, Robertson, and Campbell [16] also developed an individually tailored, home based, strength and balance retraining programme which has proven successful in reducing falls and moderate fall injuries in people 80 years and above. The programme was individually tailored as older people vary considerably in their physical capacity and health and in their response to exercise, with three major areas being addressed – strength, balance and endurance. A series of visits from the exercise instructor allowed a stable, sustainable programme to be developed which could be increased in difficulty if needed due to initial improvements in strength and balance.

Wolf et al. [64] also used an individualized training programme developed by a physical therapist to improve balance in participants who showed impaired balance during functional activities. Twelve 30-minute sessions of an individualized balance training programme over 4-6 weeks were given to the experimental group with results revealing that a short individualized exercise programme can improve balance in people aged 75 and older. This improvement was maintained for at least one month but had worn off by one year.

Supervised programmes can also be carried out in a group situation. Six weeks of supervised stretching, balance, endurance, co-ordination and strengthening exercises were performed by a group at an outpatient rehabilitation centre to assess the effects of exercise on balance, mobility, falls and injuries [36]. On completing a functional obstacle course and self-reporting falls and injuries, the exercise group significantly outperformed a control group, concluding that the intervention can improve functional performance and protect against falls and fall-related injuries.

Many other studies investigating the effects of exercise on balance have used group based exercise programmes which can be useful in helping to motivate the participant to perform the exercises. The short-term effects of an exercise-based rehabilitation intervention on balance, mobility, falls and injuries

have been investigated [36]. A trial was performed at an outpatient rehabilitation centre with volunteers undergoing 6 weeks of supervised stretching, balance, endurance, co-ordination and strengthening exercises. Data was recorded for time and quality performance on a functional obstacle course and for self-reported falls and injuries and compared to a control group who attended seminars but had no exercise intervention. The exercise group outperformed the control group on the obstacle course and reported fewer falls and fall-related injures than the control group, concluding that the intervention can improve functional performance and protect against falls and fall-related injuries. DiBrezzo, Shadden, Raybon, and Powers [14] investigated the effects of exercise on strength and dynamic balance using a 10 week exercise class plan consisting of three one hour classes per week at the local senior centre. Stretching, strengthening and balance-training exercises followed a warm-up. After completing the programme, significant improvements were observed in tests measuring dynamic balance and agility, lower and upper extremity strength and upper extremity flexibility. The results indicate that exercise programmes like this are an effective, low-cost solution to improving health and factors that affect falling risk in older adults.

Most of the previous investigations have employed self-reporting the amount of physical activity performed by adults as a method of collecting information for outcome measures. This was assessed by Hoeppner and Rimmer [21] who examined self-reported exercise and its effects on postural balance. Older adults aged between 65 and 95, who lived in a retirement home containing a supervised fitness centre reported their physical activities. Results found that regular exercise (at least 30 minutes per day, 3 days per week) and ambulation without a cane or walker are descriptors of older adults with good balance performance and high balance self-efficacy. This has important implications for reducing the incidence of falls and maintaining a higher level of mobility in older populations. Self-reporting was also used by Carlson, Kruger, Kohl, and Buchner [12] where moderate intensity activity was described as anything that caused a small increase in breathing or heart rate (i.e. brisk walking, bicycling, and gardening) and vigorous intensity caused large increases in breathing or heart rate (i.e. running, aerobics, heavy yard work). They concluded that active older adults experienced a lower reported level of falls than their inactive peers when self-reporting the amount of physical activity they performed.

Bird, Hill, Ball, and Williams [7] used either resistance or flexibility exercise programmes incorporating gym and home-based exercises to investigate their effects on balance in older adults. The results indicated that significant improvements in balance performance were achieved with both resistance and flexibility training in healthy untrained older adults. A further study comparing group and home-based exercise training in healthy older men and women concluded that a community based exercise training programme improved fitness among sedentary, healthy older adults and that home-based exercise was as effective as group exercise in producing these changes [31].

A previous study monitored daily physical activities (DPA) in a group of community dwelling older adults, investigating the relationship between balance, functional fitness and DPA (Islam, Takeshima, Rogers, Koizumi, & Rogers, 2004). However, they did not provide any information on what the intervention entailed. Although many studies have shown that a variety of settings can be used in either group or individual based activities to help encourage physical activity in older adults, there is still a paucity of information on non-traditional forms of exercise and physical activity that may serve as a change to the regular forms of activities that are generally offered to older adults.

Influence of Physical Activity on Balance

A technical definition of balance is the ability to control the body's centre of mass (CoM) within the base of support or a changing base of support while upright and performing activities [5]. Maintaining balance requires the complex interaction of neuromuscular, proprioceptive, vestibular and visual systems. The performance of many of these systems declines with age, resulting in diminished balance and an increase in falls [4]. Kahle and Tevald [27] investigated the effect of core muscle strengthening on balance in community dwelling older adults, dividing 24 healthy men and women into two groups: one an exercise group who performed a core strengthening exercise programme at home three times a week for 6 weeks and one a control group. Participants in the exercise group performed a progressive programme consisting of eight exercises designed to increase the strength and endurance of the muscles of the core. Each subject received individual instruction on the exercise programme, which consisted of demonstrating and explaining the exercises, providing written instructions and figures for each exercise and practicing the exercises with feedback from the research

assistant. Despite the sample size being small, the follow-up limited to a single post-test session and resources not allowing for a separate assessor and trainer, the results indicate that an unsupervised, short duration home exercise programme of core strengthening exercises can improve core muscle and dynamic balance as measured by the FR (Functional Reach Test) and the SEBT (Star Excursion Balance Test). The results highlight the key role of core strength in balance performance in older adults and add to the small-but growing body of literature suggesting that core muscle training should be a part of a comprehensive balance training programme.

Perrin, Gauchard, Perrot and Jeandel [44] investigated the effects of physical and sporting activities (PSA) on balance control in elderly people as it has been suggested that PSA efficiently counteracts these disorders and significantly reduces risk of falling. The study included 65 healthy subjects aged 60 years plus (mean 71.8) who lived at home. Posturographic tests were performed and postural control was best in subjects who had always practised PSA, next best in those who had lately taken up PSA (close to 1st group). Subjects who had stopped PSA at an early age did not perform well and control was worse in subjects who had never practised PSA. They concluded that PSA was extremely useful for elderly even if it had not been a lifelong habit as it may prevent reduction in muscle mass and strength and it has a positive effect on balance control.

This is supported by Hayashi et al. [20] who investigated postural balance in one hundred and fifty seven independent individuals aged 60 plus and discovered that a group with a more preserved exercise capacity had better postural balance and higher levels of physical activity in daily life (PADL) than older adults with poorer condition in terms of exercise capacity.

Buatois, Gauchard, Aubry, Benetos, and Perrin [10] investigated the influence of current and/or past Physical Activity (PA) on balance-related neurosensorial organisation in older adults on the maintenance of the upright stance, especially during sensory conflicting situations. They concluded that regular PA, even when started late in life allows appropriate reorganisation of the different components of postural control during sensory conflicting situations.

Previous studies also indicated that current activity status could play a key role in balance performance in older adults [11]. Whilst investigating the effects of former athleticism and current activity status on static and dynamic postural balance in older adults, this study showed that the physically active elderly performed significantly better on the static and dynamic balance tests than their currently inactive counterparts and that previous athletic status had no considerable impact on the results.

Types of Physical Activity

Studies have shown that a variety of physical activity and exercise interventions with balance and muscle strengthening components are effective in reducing falls and in improving physiological and functional performance in older people [66]. While it appears clear that exercise is an important component of any falls reduction programme, there is no one size suits all intervention approach and the type of activity should consider various factors: level of fall risk, physical risk factors and physical activity preference of older adults [48].

Traditional sports have been investigated for their effect on balance. Tsang & Hui-Chan [62] compared static and dynamic balance control in eleven older golfers to twelve non-golfers. Although the sample size is small, the golfers maintained significantly longer duration in static single-leg stance, achieved less anteroposterior body sway in perturbed single-leg stance and lunged significantly farther than the control group. Therefore, the better static and dynamic balance control exhibited by the golfing group possibly reflects the effects of weight transfer from repeated golf swings during weight shift from 2-leg to predominantly 1-leg stance and from walking on the uneven surface of the golf courses.

Swimming has been considered to be a very suitable exercise for older people as it is a non-weight bearing exercise, providing low-impact to the weight bearing joints of the hip, knee and ankles. Regular swimming has been reported to be beneficial in improving endurance, maximal oxygen consumption, muscle strength, body composition and bone density, with a study investigating the effect of swimming on hand eye coordination and possibly improving balance revealing that regular swimming exercise may result in

improved eye hand coordination and improved balance function under few complicated balance conditions [23].

As the mode of exercise is important for older adults, Anderson and Fishback [1] compared the effectiveness of water and land based balance specific exercise in older adults. 60 minute classes, 3 times a week for 8 weeks were offered to 12 participants. They concluded that water exercise is an important mode to consider for improving balance in older adults due to the supporting nature and the safe exercise environment of the water.

Kaneda, Sato, Wakabayashi and Nomura [28] support this by identifying a water exercise programme including deep-water running which is beneficial for improving dynamic balance ability in the elderly.

Water-based exercise has also been compared to land-based exercise by Bergamin, Ermolao, Tolomio, Berton, Sergi & Zaccaria [6] who investigated the effectiveness of a 24-week exercise protocol carried out in geothermal spring water to improve overall physical function and muscle mass in a group of healthy elderly subjects. This protocol was also compared to a land-based protocol. Various physical tests were performed, with knee-extension strength being maintained in both groups, back scratch test improving in the aquatic group only and the sit and reach test improving in both. The aquatic group reduced fat mass by 4% and dominant forearm fat by 9.2% while increasing calf muscle density by 1.8%. Both land and water based activities proved beneficial in maintaining strength and improving lower-body flexibility, with the aquatic exercises appearing a better way to improve dynamic balance.

Traditional aerobic dance exercises have been utilised to determine the effects of this type of exercise on elderly adults. Hopkins et al [22] investigated the effect of low-impact aerobic dance on the functional fitness of sedentary elderly women, concluding that following a 12-week plan, the group significantly improved on several functional fitness components, one of which was balance.

This is supported by Shigematsu et al [52] who used a 60-minute dance-based aerobic exercise programme, 3 days a week for 12 weeks, specifically designed for older women. They concluded that the

programme might improve selected components of balance and locomotion/agility, therefore attenuating risks of falling.

Dynamic balance and agility showed an improvement of 19% following a 12-week step aerobics-training programme for previously sedentary elderly women [19]. Subjects performed 3 training sessions per week for 30-60 minutes per session, with results demonstrating that the 12 weeks of step aerobics increased strength, balance, agility and flexibility in older adults.

The intensity of exercise can also be important as Pau, Leban, Collu and Migliaccio [43] demonstrated. They investigated the effect of light and vigorous physical activity on balance and gait in older adults. All participants performed the same exercises but to a different intensity – the vigorous group keeping Heart Rate Reserve (HRR) between 60-84%, with the light group maintaining HRR below 40%. They concluded that although motor tasks such as Sit to Stand and gait are likely to receive superior benefit from higher intensity training, there are also benefits from light training such as greater safety, ease in training, less supervision required and easier to inspire the adult group, together with a decrease in postural sway which can be obtained even with low levels of physical activity intensity.

The intensity of activity was also investigated by Kramer, Creekmur, Mitchell, Rose, Pynoos and Rubenstein [32]. Three progressive-intensity fall prevention programme models were designed to reduce fall risk in community-dwelling older adults. Each model consisted of three components: physical activity, medical risk and home safety evaluation. The physical activity component had three intensity levels – high, medium and low. Although the overall programme is associated with reduced falls, the program intensity level did not have a major effect on falls.

Much of the research reviewed used gym type exercise programmes with specific individual or group based exercises. The activities included balance and strength exercises, tailored walking programmes, exercises whilst standing, sitting, walking and balancing during daily activities, supervised stretching, endurance, co-ordination and strengthening exercises. Resistance training and the use of stationary bicycles were also used.

Robitaille et al [46] developed a multifaceted group based fall prevention programme for older independent adults with a history of falls or who worried about their balance, finding that the intervention significantly improved static balance and mobility. It was concluded that structured, group-based exercise programmes offered by community organisations in natural settings can successfully increase balancing ability among older adults concerned about falls.

Exercise programmes that are easy to adhere to and not expensive may be more attractive to the older population. Paillard, Lafont, Costes-Salon, Riviere & Dupui [42] investigated the effects of brisk walking on static and dynamic balance in ageing healthy active men. The walking programme consisted of 5 sessions a week for 12 weeks, with the group showing significant improvement in dynamic balance performance, an increase in VO2 max and loss of fat mass, suggesting that the programme may have positive effects on preventing ageing subjects from falling.

The effects of regular walking on postural stability in the elderly has also been studied [37]. An observational study was performed to explore whether walking on a regular basis may prove to be beneficial to maintaining good balance as well as benefiting the cardiovascular system. They did find that healthy older subjects who walked on a regular basis since their retirement have better postural control, especially in static balance than those who do not. Although older subjects who walk regularly walked much more than non-walkers, they did not suffer from falls.

To examine the effects of a lower-extremity strengthening, walking and postural control exercise programme, 21 healthy, older women were assigned to either a treatment group (combined training) or a control group (flexibility training) for 6 months [26]. This was the first report of an intervention trial that improved force-plate measures of static balance in neurologically intact older people, supporting the hypothesis that an exercise programme emphasizing postural control, moderate resistance training and walking improves single-stance balance. However, these findings are preliminary and will require confirmation in a larger study.

Effects of resistance training compared to aerobic exercise in elderly people concerning physical fitness and ability were investigated [47]. Resistance exercises were performed in an experimental gym for 1

hour, twice a week for 12 months, with the aerobic activity performed on a walking track, with training lasting for 30 minutes, twice a week for 12 months. Results revealed that the resistance group improved flexibility and static balance, with the aerobic group improving gait speed, and static balance, concluding that both activities are efficient in improving physical fitness and functionality in the elderly population. While supervised physical activity interventions have been successful in increasing physical activity in older adults over the duration of the exercise intervention, there is poor maintenance of exercise behaviours in the longer term [8]. The aim of their study was to identify long-term changes in balance, strength, mobility and activity levels in a group who participated in a flexibility and resistance training programme in a community gymnasium compared to a control group. Secondary aims were to identify perceptions of improvements in function at 12 months, and for the exercise group, factors influencing ongoing exercise participation. They concluded that long-term benefits to some measures of balance and mobility exist 1 year after participation in a programme that includes resistance and flexibility exercise training. This community-based gymnasium programme has resulted in moderately high levels of continued participation in resistance training 1 year after cessation of formal exercise. Motivation to continue resistance training may be supported by real and perceived benefits in this form of physical activity.

As shown, many physical activity training programmes have recognised health benefits and much of the evidence suggests that training should include a combination of progressive resistance, balance and functional training. Seco et al [49] aimed to assess the effects of a simple physical activity programme working on strength, flexibility, cardiovascular fitness and balance in older adults, together with observing the effects of a detraining period. Results demonstrated significant improvements in strength, flexibility, heart rate after exercise and balance at the end of the training programme, together with flexibility and balance improvements being maintained at the end of detraining (3 months later). They concluded that a simple long-term activity training programme can increase strength in both sexes, improve flexibility in women and improve balance in older adults, indicating the importance of beginning in old age and maintaining long-term training.

Many studies investigating physical activity and balance in older adults have focused on exercise programmes devised by physical therapists or incorporated gym-based stretching and strengthening

exercises. Barnett, Smith, Lord, Williams & Baumand [2] used a weekly group exercise programme and home based exercises devised by a physiotherapist over one year and found that balance improved and the rate of falling reduced in at-risk community dwelling older people.

Various other forms of activity and exercise programmes have been studied to incorporate into older adults' lifestyle and help improve balance and prevent the risk of falls. Bissonnette, Weir, Leigh & Kenno [9] investigated the effects of whole-body vibration (WBV) exercise on flexibility, balance and strength changes in older adults. These exercises are completed using a WAVE Pro, a vertically oscillating platform causing involuntary muscle contractions leading to increases in muscle strength, bone mineral density, circulation as well as balance and flexibility. All participants in the study experienced positive changes in their functional movements, suggesting the WBV training is appropriate for promoting flexibility, balance and strength in older adults. However, this would not be a widely available piece of equipment and future research needs to directly compare WBV exercises with more traditional forms of exercise.

Novel activities to improve compliance with exercise programmes could be to use interactive videogames combining player movement, engaging recreation, immediate performance feedback and social connectivity via competition [54]. By employing a videogame, Dance Dance Revolution (DDR), this study asked the participants, aged 70 years and above, to make simple step movements in response to vertically drifting arrows presented on a video screen. Characteristics of stepping performance, such as step timing, percentage of missed target steps and percentage of correct steps were recorded by purpose-built software. Results indicated that older adults are able to interact with video games based on the DDR effectively, suggesting that these novel games are a low-cost method by which older adults can be engaged in exercises that challenge balance and can be conducted in their own homes. In a further study, healthy older adults aged 80 plus participated in interactive video dance games adapted for older users. Completers of the study were healthier than those who did not complete and showed improvement in self-reported balance, confidence and mental health [55].

Toulotte, Toursel & Olivier [60] also investigated use of video games, with participants including Wii Fit games as part of their activities and comparing this to participants using Adapted Physical Activities (APA). The message they concluded was that Wii Fit only improves activities on static balance in bipedal conditions, contrary to ADA, whereas ADA training alone improves balance and adding Wii Fit does not confer a major additional benefit.

Pluchino, Lee, Asfour, Roos and Signorile [45] compared a video balance board programme performed at home to Tai Chi and standard balance exercise programmes, concluding that the video game programme was as effective as the other two interventions in improving postural control and balance. This may have implications for exercise adherence due to the home-based nature of the video intervention that can eliminate many of the obstacles found during exercise training.

Modern technology in the form of an IT-based system running on a tablet has also been used to motivate and assist physical exercise in independently living older adults. The training application assists, monitors and motivates the elderly to follow personalized training plans autonomously at home while integrating them socially [53]. They concluded that the system has valuable potential to support and motivate independently living elderly to autonomously perform balance and strength exercises.

Other activities such as Tai Chi have been recognised as effective interventions for fall risk prevention in older people. Many studies have demonstrated that performance on balance measures can be improved for older subjects by practising Tai Chi [34, 67]. Taggart [56] studied the effects of Tai Chi exercise amongst older women and found that three months of a twice weekly, 30 minutes Tai Chi class was associated with statistically significant improvements in balance and functional mobility and a reduction in the fear of falling in this group.

Tsang & Hui-Chan [61] compared 12 experienced elderly Tai Chi practitioners to 11 experienced elderly golfers, 12 healthy elderly subjects and 12 young university students (all male). The results demonstrated that both the experienced Tai Chi practitioners and golfers had improved knee joint proprioception and

limits of stability when compared with those of the elderly control subjects similar in age and physical activity level, and were comparable to those of young male subjects. The results suggesting that experienced Tai Chi practitioners and golfers had improved joint proprioception acuity and dynamic standing balance control, despite the known ageing effects in these specific sensorimotor functions.

The effects of Tai Chi was compared to those of Western Exercise (WE), consisting of endurance, strength, and flexibility training, and a control group [57]. The two exercise interventions involved a combined class and home based protocol to maximise long term participation. Physical-functioning measures included balance, muscle-strength and endurance, flexibility, and cardiorespiratory endurance. Results showed that participants assigned to WE had greater improvements in upper body flexibility than the other two groups, and participants assigned to Tai Chi had greater improvements in static balance. In addition, the statistically significant 12-month improvements in both exercise groups for measures taken during the submaximal treadmill testing, an indicator of cardiorespiratory endurance, support the adequacy of intervention exercise dose for each group. Furthermore, on average, participants in both the Tai Chi and WE groups increased their frequency of moderate-intensity activities between baseline and 6 and 12 months, with greater increases reported in the WE group. The study concluded that both Western and Tai Chi exercises can have positive, though somewhat different, impacts on a variety of functional domains, including physical and cognitive function. The potential impact of Tai Chi on cognitive function, in particular, deserves further investigation [57].

As Yoga is a form of exercise that challenges balance, a pilot study was conducted to evaluate the feasibility and effect of a 12-week yoga programme on balance and mobility in older people [58]. Two groups were observed: an intervention group who participated in a 12-week, twice weekly yoga programme while receiving a fall prevention booklet, and a control group who received the education booklet only. The intervention group significantly improved compared to the control group on standing balance, sit-to-stand test, 4 metre walk and one-legged stance with eyes closed. The conclusions were that the trial demonstrated balance and mobility-related benefits and feasibility of yoga for older people.

Tae Kwon Do has also been shown to be an effective exercise for improving balance and walking ability in older adults .The Tae Kwon Do movements emphasize dynamic movements which are typically deficient in the older adult walking pattern and improving balance and walking ability through this exercise may serve to restore function that has declined with age and preserve mobility for older adults [13].

Another form of exercise, Nordic walking, is a simple, well-tolerated and effective physical activity that can be advised for older people [63]. Their study showed that older adults participating in a 10 week supervised Nordic Walking programme and a 25 week unsupervised period improved in areas of balance, functional mobility and aerobic endurance compared to a control group, concluding that Nordic Walking can play an important role in geriatric physiotherapy in order to improve or maintain functional abilities of this growing population.

Dance related activities

Several studies have investigated the effects of different genres of dance on balance in older adults as it is thought that a dance-based exercise approach may make the exercise more interesting to the older population. Dance incorporates rhythmic motor coordination, balance and memory, social interaction as well as requirements of physical activity, making it a potentially powerful intervention. It has been established as a therapeutic tool for the treatment of Parkinsons Disease, overweight children and patients with serious mental illness. Kattenstroth, Kalisch, Holt, Tegenthoff & Dinse [29] investigated the effects of a 6-month dance class (1 hour per week) on a group of healthy elderly individuals compared to a matched control group. The special dance programme was developed for the elderly, with an important aspect of this programme being that the dances can be performed without a partner, being particularly attractive to older solitary people. After 6 months beneficial effects were found in the dance group, including improved cognition, reaction times, tactile and motor performance and enhanced postural stability as the subjects were able to shift COP (Centre of Pressure) further without taking a step forwards or falling.

Merom et al [40] provide a protocol to investigate the effect of social dancing on preventing falls in older adults, with the aims to determine whether a typical community social dance programme i) reduces

the number of falls; and ii) improves cognitive factors associated with fall risk in older people. They will utilise two dance styles: Folk and Ballroom. These styles were not manipulated to mimic exercise training nor did they incorporate specific strength or balance training. This study aims to determine the effectiveness of social dance as a fall prevention strategy and its potential in the prevention of cognitive declines. It offers a novel approach to balance training for older people, by examining an enjoyable activity that is holistic in execution. As a community-based approach to fall prevention, dance offers older people an opportunity for greater social engagement, thereby making a major contribution to healthy ageing. Providing diversity in exercise programmes targeting seniors recognises the heterogeneity of multicultural populations and may further increase the number of taking part in dance classes.

The Argentine tango is a dance that encourages multi-directional steps, quick turns and moves performed standing on one leg incorporating strength and flexibility. A study comprising of two hours of dancing twice a week for ten weeks found that using Argentine tango as a physical activity is feasible in a population of elderly individuals and has been shown to improve both physical fitness and balance for individuals at risk for falls. However, the study needs to be repeated with a greater sample size [35]

Excellent compliance was seen in a group of healthy older adults when participating in an 8-week salsa dancing programme, showing the activity to be a safe and feasible exercise programme for older adults, together with indicating an improvement in selected measures of static postural control [18].

Further studies include the adaptation of country specific dances, with one study investigating an eight- week Turkish folklore dance based exercise programme, performed using 40 healthy adults over the age of 65 years. Improvements were observed in physical performance, balance and quality of life in the group of elderly females, suggesting that applying folkloric dance specific to countries as an exercise programme for elderly people may be helpful [15].

Therefore, other different sports/activities should be investigated to see if they improve balance in older adults and possibly lead to a decrease in the rate of falling.

Ice skating as an intervention

Public health recommendations for older adults highlight the need to engage in a combination of aerobic, muscle strength, flexibility and balance activities [39]. Social dancing is an activity performed with relatively moderate intensity and is therefore appropriate for elderly people, being associated with enhanced postural stability and physical performance in this group [68]. Keogh, Kilding, Pidgeon & Gillis [30] reviewed the physical benefits of dancing for healthy adults and concluded that dancing is a form of physical activity that may allow older adults to improve their physical function, health and well-being by improving their aerobic power, lower body muscle endurance, strength and flexibility, balance, agility and gait. They also suggest that dancing might improve older adults' lower body bone-mineral content and muscle power, as well as reduce the prevalence of falls and cardiovascular health risks. Further research was recommended to determine the efficacy of different types of dance, the relative effectiveness of these forms of dance compared to other exercise modes and how best to engage older adults in dance participation [30]. Following this, the effects of ballroom dancing on balance and functional autonomy among isolated elderly individuals has been studied, with the results inferring that individuals who are residents of long term institutions can improve their functional autonomy and balance with a ballroom dance programme [17].

Other sports and activities that combine these characteristics together with having a social aspect where older adults can perform their sport together should be investigated as well as the gym and home based exercises described in many of the previous studies. As people age, they believe attractive physical activity options are not available, although research shows they express a desire to pursue new activities [25].

It has been suggested that exercise activities which challenge balance are the most effective at improving it. According to the best practice recommendations, exercise that provides moderate to high challenges to balance abilities should include; i) movements that reduce the base of support (e.g. standing with both legs close together, standing on one leg), ii) movement of the centre of gravity (e.g. control of the body's

position while standing, reaching or stepping) and iii) the above movements without upper limb support [50]. Ice skating is an activity that provides these characteristics and challenges.

Many of the studies investigating balance programmes are based on setting up a training programme for a limited amount of time. If postural control is reflected in athletic skill level in young subjects, these findings could be taken to imply that that elderly who have performed a life-long sports activity will have a more efficient postural control than sedentary individuals.

With the increase in prime time reality television exposure, ice-skating is an activity that older adults may wish to pursue. Research has shown that postural control in an elderly population that had always ice-skated was found to be more similar to that of young adults than that of inactive elderly [33]. These results imply activities such as ice-skating are beneficial for elderly people and might counteract age related changes in postural control. Ice-skating puts specific demands on balance and physical fitness as the skating movement and surface continuously challenge balance, requiring accurate movements of the centre of mass within the limits of stability, thereby facilitating the neuromuscular control system [33].

Identifying combinations of activities that address several dimensions of fitness, including balance, to reduce the burden of falls, injuries and chronic diseases is a public health challenge [39]. King, Haskell, Taylor, Kraemer & DeBusk [31] questioned whether popular recreational leisure time activities can be effective in preventing falls and if this is worth exploring as it may increase the sustainability of participation by providing more variety to choose from.

A sport such as ice-skating should be investigated as an exercise intervention to inspire the older independent adult generation to participate in a new community based activity, helping improve balance, decreasing the risk of falls, together with improving mood and well-being.

Conclusion:

The majority of people feel that physical activity should be engaged in throughout their life and they acknowledge the benefits of being physically active [25]. Many people report a desire to return to activities such as netball, tennis, squash, dancing, badminton, swimming, cricket; activities they had been involved in during their past but feel would be difficult to participate in now. Many participants in the study by Jancey et al [25] expressed a desire to pursue new activities but they usually identified some limitation that would inhibit them from attempting the activity. Ice skating was one activity that older adults would like to initiate and maintain. Older adults' motivation to partake in physical activity may be solely for health reasons rather than also the enjoyment of being physically active and therefore attention should be paid to the relationship between enjoyment and physical activity. Further investigations needs to be conducted into activities that are not generally considered appropriate for older people but may be enjoyable and have health benefits [25]. Ice skating is a non-traditional activity that can be taken up in later life and is enjoyed by many people. It is a social activity and has health benefits as it can be used to improve balance, prevent falls and improve mood and well-being.

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