Effects of physical activity on postural stability

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Introduction

Fall-induced injuries are increasing more rapidly than demographic changes can account for [1]. The potential effects of a fall include not only injury or death but also fear of further falls (which limits activity and makes the situation worse), depression and other psychological sequelae [2]. The scientific evidence regarding the role physical activity has to play in falls management is confusing and inconsistent. Physical activity and exercise have been identified as major factors that influence the risk of falls and fractures among older adults.

Physical activity describes any body movement that substantially increases energy expenditure. It is commonly divided into occupational and leisure activity. Physical activity can range from everyday actions (e.g. walking, heavy housework and gardening) or leisure activities such as swimming, dancing, cycling or sporting and exercise opportunities provided in gyms and fitness centres. Whereas exercise is used to describe planned and structured activities where repetitive body movements are made to improve or maintain components of fitness (e.g. strength training or a fitness programme designed to improve cardiovascular risk or reduce falls). Accumulating evidence indicates that physical activity and structured exercise help maintain an independent life by maintaining postural stability (balance), strength, endurance, bone density and functional ability and, in so doing, may prevent falls and injuries associated with falls in older age (Figure 1). But some types and patterns of physical activity or exercise do not seem to improve postural stability, let alone prevent or reduce the risk of falls. Indeed, some activities seem to increase the risk of falls, either by increasing exposure to risky environmental conditions (slippery or uneven floors, cluttered areas, bad pavements), acute fatigue, or unsafe practice (Figure 1).

There have been calls for advice on prevention and treatment initiatives in relation to falls and fall-related injuries and for evidence of effectiveness, or models of practice [3]. This paper reviews the scientific evidence regarding the role that physical activity has to play.

Low levels of physical activity and exercise with increasing age

Physical fitness (e.g. adequate strength, power, flexibility, balance and endurance) is especially important in old age, in order to cope with everyday tasks and any unforeseen demands such as hills, uneven ground, trips etc., on the ageing body [4]. Over the past 50 years, due to a massive increase in labour saving devices and overall mechanization, the amount of daily activity we are required to do has drastically decreased; the consequences of our sedentary lifestyles are now reflected more than ever in the health of our older population. The Allied Dunbar National Fitness Survey [5] in the over 50's found that 40% are sedentary and that over 25% of all 70 year old men, and a staggering 80% of all 70–75 year old women, are unable to do even simple tasks such as walk a quarter of a mile comfortably on their own. Activity was graded not just in taking part in structured exercise, but other activities such as heavy housework, heavy gardening and DIY and walking. One third of the over 70's climb no stairs and only 13% of men and 11% of women aged 50+ took part in sports and exercise activities once a week or more. The most commonly reported activity was ‘Keep Fit exercises’ for both sexes [5].

Decreasing physical capacity takes older people closer and closer to critical ‘thresholds’ of performance necessary for everyday activities. In particular, decreasing strength, balance and co-ordination appear to be key factors in maintaining upright posture in dynamic situations [4]. This can be illustrated by the change in site of fracture with increasing age—wrist fractures become more common in the 40s and are prevalent up to the age of 65—with slowing reaction times it is often no longer possible to get the hand out fast enough to prevent the body landing heavily on the hip and trunk;
hence fractures of the hip become more prevalent after the age of 80 [6].

**Postural stability, age and activity**

Balance is a complex automatic integration of several body systems. With age and inactivity these unconscious processes may not integrate as well or as quickly as they did when the person was younger. Maintaining balance and preventing injurious falls can become problems that require an ever increasing focus and fatiguing effort. Most cross-sectional studies show that with ageing there is a slowing in sway, gait patterns have a wider base, there is an increased time in double leg support phase of walking as well as a decrease in stride length, a decrease in trunk rotation and an increase in pain and discomfort that limits movement [7]. Sedentary older adults are also known to adopt a more cautious walking style with shorter step lengths and slower step velocities than active older adults [8]. When required to increase walking speed, older people tend to increase their cadence rather than their stride length, younger people do the reverse. Disease such as peripheral neuropathy, arthritis and osteoporosis cause further gait adaptation. Other age-related effects also affect balance; the sensitivity of skin receptors (oedema, arthritis and medications), reflex speeds or reaction time slows, co-ordination gets worse (particularly hand/eye), poor eyesight and vestibular dysfunction (often medication related).

One cross-sectional study shows close positive association with the amount of physical activity reported and postural stability in postmenopausal women [9]. The period of life during which physical and sporting activities are practised seems also to be of importance [10]. Recent periods of activity in over 60 year olds have greater beneficial effects on postural stability than activities performed only at an earlier age (30–40s). People who had only taken up physical activity after retiring had responses close to those who had always been active but were better than those who had become sedentary in their 30–40s or those who had never been particularly active [10].

**Falls**

It appears that regular physical activity is an important preventative measure against falls [6, 11] and against hip fractures, with the risk of those who take regular activity being more than halved [6, 12].

It is also common for fallers to have poor balance. Poor balance is associated with an increased risk of falls (Odd Ratio 2.6) and more strongly with recurrent falls (Odd Ratio 5) in community dwelling 70 year olds [13]. This trial found no association of physical activity with either falls or recurrent falls in a group of community dwelling over 70 year olds [13]. Some researchers measure physical activity by questionnaires, some by heart rate monitors, others by diaries and it is likely that these differences in measurement of physical activity is one of the reasons for inconsistencies. Muscle function is so strongly associated with physical activity it may be hard to prove that both physical activity and postural

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**Figure 1.** Physical activity and exercise: Effects on postural stability and falls. Bold lines represent strong evidence from RCT trials and Epidemiology. Dotted lines represent weaker evidence, or data from a few selected trials.
stability have unique contributions to play separate from their united role.

Frequent fallers have a very poor prognosis, especially if they live alone and are prone to waiting hours before they are found or can get attention [14]. One problem is often that people fall and despite there only being a minor injury they are not able to get up off the floor without help. If they cannot get up without help then they are more likely, on 21 month follow-up, to have died, to be hospitalized and to suffer functional decline [15]. The role of activity in maintaining core body temperature whilst on the floor should not be forgotten. Some of the difficulty of rising from the floor may be shock or injury but for many it is simply lack of fitness. The largest call out for the London Ambulance is for people aged over 65 who have fallen, yet 40% of these people are not conveyed to Hospital, merely picked up [16].

Modifiable risk factors for falls

Leading a sedentary lifestyle has been identified as a factor for increased risk of falls in many trials [11, 17]. Fallers tend to be less active and may inadvertently cause further atrophy of muscle around an unstable joint through disuse [18].

It is common for fallers to have weak muscles, Whipple showed that nursing home fallers had only 60% of the quadriceps strength of the non-fallers in the home, and only 30% of the strength of community dwelling non-fallers [19]. In community dwelling fallers, however, quadriceps, hamstring, hip extensors and ankle plantarflexors appear similar to people who do not fall, but ankle dorsiflexion and lower limb power are weaker [20]. In independent older people, power appears more predictive of functional decline than strength *per se* [21, 22]. Lower limb power asymmetry also presents more frequently if a person is a faller [20]. Explosive power is important in correcting a displacement or movement error; to prevent a trip an individual must have sufficient lower limb muscle power to get a stabilizing leg out fast enough to prevent the fall or reduce the severity of the effects of the fall. One slow and weak leg may be enough to not lift a foot high enough to miss a step, or to not be able to respond fast enough if needed to stabilize the body.

One of the strong predictors of fall status is the clinical test ‘stops walking when talking’ [23]. Multiple tasks performance becomes much harder with disuse and fearful older people tend to avoid doing more than one thing at once. *Grabbing great grandmas* (hold onto objects as they walk) and *patients with precious parking* (sit down too early and miss the seat) are two types of fallers seen in clinical practice [24]. Both groups show clear signs of *fear of falling* which can alter their postural stability [25] and often induce another fall [24]. Movement errors or novel movements are known to facilitate the acquisition of motor skills so conversely fallers may inadvertently cause a loss of postural skills by constraining their own movements [26].

Postural stability and physical activity and exercise

Many of the risk factors for postural instability are purely due to inactivity or ageing muscles and body functions [27]. Tailored balance training and Tai Chi have been shown to improve postural stability [28–30]. Exercise should help in both the correction of displacement (stronger muscles and better balance, co-ordination and reactions all have a part to play), as well as in the perception of displacement (by reducing oedema, increasing range of motion of the ankle and reducing arthritis, proprioception and sensation can be improved). Body management and postural training will help remind the body where it is in relation to its environment [18].

Fear of a further or more injurious fall tends to limit exercise gains during a supervised class. One study looked at exercise designed to reduce postural instability in a risk-free environment—water [31]. They considered two exercise groups, one water-based and one land-based, both of which exercised for 5 weeks. The water-based group increased their functional reach (a risk factor for falls) to a greater extent than the land-based group [31]. Another way to increase confidence in taking part in activity is the use of hip protectors, which allow even frail elders to take part relatively safely in movement [18].

The foremost worry for any health professional working with unstable older people is that the person falls whilst exercising or taking part in any activity. Physical activity generally involves the use of large movements that displace the body’s centre of gravity and therefore taxes balance. Some studies suggest a U-shaped association, in which the most inactive and the most active persons may be at the highest risk [11, 32]. A recent trial considering the effect of brisk walking on osteoporosis found that the cumulative risk of falling was higher in the intervention group [33]. Qualified, experienced, exercise practitioner supervision together with a graded strengthening and walking programme prior to commencement of walking outdoors may contribute to better outcome measures. Obviously water based exercise would take away this worry but many older people do not swim, find many pools too cold for comfort, or would be unhappy exercising so scantily clad.

Falls and physical activity and exercise—specificity

Despite the obvious role that lack of exercise has on increasing the risk of falls, the evidence that exercise
alone can reduce the risk of falls is inconsistent (for reviews; [18, 32, 34, 35]). There are quite a number of reasons for this inconsistency. Several trials have used exercise of insufficient duration, intensity (overload) or frequency necessary to effect change to the persons gait or movement patterns. Other trials have only minimally documented the types of exercise or activity used. Studies which have not shown a reduction in risk of falls, with supervised exercise, have often omitted to take prospective fall data, relying rather on the persons recollection and indeed, definition of a fall. Finally, many trials failed to target their subjects and included non-fallers in short-term interventions. As exercise must be specific to the task, if the subjects were not fallers pre-intervention, then one should not expect to reduce the number of falls.

Although many exercise programmes have targeted components of fitness aimed at improving the known risk factors for falls, some have shown no reduction in risk even with improvements in strength, balance or co-ordination (for review; [18, 34, 35]). For example, Millar considered seated balance exercise as part of a multifactorial intervention and found a significant reduction in prevalence of postural hypotension but no difference in fall rates [36]. Another trial found improvements in strength with progressive exercise but no change in fall risk [37]. It is possible that for a successful intervention, more than one or two musculo-skeletal risk factors must be targeted at once or that individual tuition is needed so that an individual's risk factors can be assessed rather than the groups.

The need for specificity was seen within a large series of randomized, controlled trials called the FICSIT programme [28]. The combined reduction in risk of falls for all these interventions was 10%. However, those trials which concentrated mainly on balance training saw a reduction in risk of some 25%. The one intervention that considered Tai Chi alone found that it delayed the onset of the first or multiple falls by 47.5%, significantly better than computerised balance training (feedback sway training) [38].

The Atlanta FICSIT site compared Tai Chi training with computerised balance training and with a control group [38]. They found that postural sway was reduced in the computerised balance training group but not in the Tai Chi or control group. Because Tai Chi delays the onset of the first or multiple falls in older people it was suggested that Tai Chi increases confidence by reducing fear of falling (44%). Forrest showed that after Tai Chi training there is a counterintuitive reduction in anticipatory postural adjustments and greater stability of standing posture [39]. This was interpreted as a greater use of the elasticity of the peripheral structures (involving muscles, ligaments and tendons). The three-dimensional continuous, controlled, nature of the Tai Chi movements, together with the change of head and eye position may also be significant. The problem with blanket prescribing of Tai Chi to people with postural instability is that many Tai Chi classes are aimed at a younger population with better postural stability and better strength. Also, few practice current exercise warm-up guidelines or adapt the moves appropriately for older people. A frail older person will find this level of Tai Chi class too demanding and may well be at risk of a fall during the class. Tai Chi teachers should be trained or experienced with working with older people and should adapt the class to progress slower and to improve strength and balance before the more demanding moves of Tai Chi are applied [18].

An individually tailored and supervised year-long home-based programme of strength and balance exercises (twice per week) and 5 minutes walking (everyday) can also reduce the risk of a future fall in women aged over 80 with and without a previous history of falls [40]. The intervention was initially delivered by a Physiotherapist with the self-directed phase being sustained with progressively frequent telephone contact to assist compliance. However, when the same programme was extended to over 65 year olds, although there were improvements in strength and balance, fall risk was not reduced [34].

The ‘belonging’ to a group allows better adherence to exercise both in the community and following a research trial [4]. A supervised class allows faster progression of training, greater individual feedback, a secure environment, peer support, an opportunity for social interaction, acceptable touching and a reduction in feelings of isolation (Figure 2). It also provides a valuable weekly report back mechanism, reinforcement of exercise technique and intensity, all of which help to sustain adherence and effectiveness of the home exercise sessions [18]. The psychological and health benefits of a regular class environment should never be ignored in preference for a seemingly more cost-effective intervention [4]. Floor coping strategies, transfer skills and keeping warm while on the floor can be practised safely in a group environment [18].

Physical activity and its role in fall prevention is still an enigma, mostly due to the different methods of measuring physical activity, the many and varied types of physical activity and the difficulty in looking at long-term adherence to unsupervised activity. One long term (10 year) follow-up of regular walkers again showed the importance of specificity, for although the health of the walkers was better than those who were sedentary, there was no significant reduction in the number of falls they had compared to the group who stopped regularly walking [41].

Conclusions

Many recent reviews have agreed that exercise is effective in lowering falls risk in selected groups and should form part of falls prevention programmes [4, 32, 34, 35]. Despite the inconsistent evidence there have been guidelines published on the recommended use of
Through all the inconsistencies there remains one clear fact—muscle function and fitness are essential to an independent life. Physical activity must be specific to its purpose. To improve health and modify certain risk factors for falling (such as strength and balance), moderate physical activity is appropriate. To reduce falls the activity should include training in balance, strength, co-ordination and reaction times but, to reduce fractures, weight resisted exercise is necessary [3]. It must, however, be recognized that physical activity and exercise take many forms and the selection of activity exerts an important influence on the balance between benefit and risk.

Some activities (often high intensity or duration) may put some people (particularly fallers) at increased risk of falls during the activity and so care should be taken in advice given. There is still much research needed on the types, amounts, variety and safety of physical activity and structured exercise for the effective prevention of falls. There is also a need to develop and include safe and effective balance training equipment in the leisure and gym environment, for preventative training and for specific exercise referral schemes that may wish to focus on falls prevention in older patients.

There are many barriers to physical activity for the over 50s, including inadequate information from health professionals [3]. However, the role of exercise in maintaining quality of life, even if it does not reach its intended aim of reducing falls, must not be underestimated [18]. Having confidence in balance and movement, the fitness to be able to correct a trip or get up from the floor unaided, and the coping strategies for keeping warm and reaching help, are all vital to an independent life.

The New National Service Framework for Older People [42] acknowledges the evidence base relating to the role of physical activity and exercise in Standard 8 ‘The promotion of health and active life in older age’,

\[\text{Positive recommendations for exercise from Feder et al., 2000 [35].}\]

- Individually tailored exercise programmes administered by a qualified professional* reduce the incidence of falls in a selected high-risk group living in the community.
- Exercise programmes reduce the risk of falls in a selected group of older people with mild deficits of strength and balance living in the community.
- Tai Chi classes with individual tuition can reduce the risk of falls in older people.
- Programmes that combine interventions (multifaceted—most that include exercise) reduce falls.

*physiotherapist, nurse trained in specific one to one balance work or an exercise instructor with seniors exercise and specific postural stability training for the older adult qualifications

\[\text{Figure 2. The components of a holistic exercise programme for prevention and management of falls.}\]

\[\text{Figure 3. Guidelines for the prevention of falls in people over 65.}\]
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Standard 3 ‘Intermediate Care’, Standard 5 ‘Stroke’ and, particularly it’s role in postural stability in Standard 6 ‘Falls’. The recent Joint American Geriatrics Society and British Geriatrics Society Guidelines for the prevention of falls recommend the ‘Get Up and Go’ test to check for difficulty or unsteadiness, balance is the key assessment in clinical practice [43].

References


