

The Role of Physical Activity in the Prevention of Falls in Older Age.

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Falls among older adults are costly for the individual and society. Regardless of the medical care system that is studied, the economic burden caused by fall related injuries is substantial for developed countries<sup>1</sup>. In the United States alone, direct medical costs totaled \$0.2 billion dollars for fatal and \$19 billion for non-fatal injuries sustained by adults aged 65 years and older in 2000. In an effort to address these alarming statistics, a large number of randomized clinical controlled trials have investigated the efficacy of a number of different intervention strategies. Among the most promising strategies studied are those that include physical activity or exercise as either a stand-alone strategy or core component of a multifactorial intervention approach. This review paper will begin with a discussion of the various research findings that provide support for exercise as a core component of any fall risk reduction program. How these findings can inform practice will be the focus of the second part of this paper. Future directions for research and practice will constitute the final section of the paper.

Regular participation in physical activity is not only integral to the maintenance of good health and functional independence in older adulthood but will also lower the risk for falls and fall-related injuries. Conversely, physical inactivity doubles the risk of developing a disability that will adversely affect mobility as well as the ability to perform even the most basic activities of daily life. This downward spiral in physical function will ultimately increase the older adults' risk for falls<sup>3</sup>. Depending on the level of fall risk identified, physical activity may serve a primary, secondary, or tertiary role in the

prevention of falls. In its primary role, regular engagement in physical activity can prevent the onset of pathology and system impairments that may lead to disability and heightened risk for falls. Slowing the progression of disease and system impairments is its secondary role, while its tertiary role lies in the restoration of function to a level that allows for more autonomy in the performance of daily activities<sup>4</sup>.

### **The Benefits of Physical Activity (and Exercise) in Reducing Falls: Overview of Research Findings**

More than 60 randomized controlled trials investigating the benefits of exercise for reducing fall risk and fall incidence rates in the older adult population, either as a stand-alone intervention strategy or as a component of a multifactorial intervention strategy, have been published over the past two decades<sup>5</sup>. Intervention strategies have consisted of single exercise (e.g., resistance exercise, walking, tai chi) or multicomponent exercise programs (e.g., aerobic endurance, flexibility, strength, and balance training). Some interventions have adopted a general approach, while others have included exercises that specifically target balance and gait impairments and other physical factors known to be associated with heightened fall risk, such as muscle weakness or reduced flexibility<sup>6-14</sup>. In addition to the different types of exercise, the methods of delivery (i.e., group-based versus one-to-one) and intervention setting (i.e., community, home, nursing home) have also differed across studies. Finally, the type of provider (e.g., physical or occupational therapists, nurses, physical activity instructors) responsible for designing and/or implementing the exercise intervention also has varied across studies.

The multi-center FICSIT (Frailty and Injuries: Cooperative Studies on Intervention Techniques) randomized controlled trials represented the first systematic and

large-scale attempt to investigate the efficacy of exercise (both targeted and non-targeted) on a number of difference performance measures related to frailty as well as fall incidence rates among older adults. Although the interventions varied with respect to the type of exercise used and the intensity, frequency, and duration of the intervention, the combined multi-site outcomes demonstrated a significant reduction in the risk of falling for the interventions that included exercise as a core component (i.e., 13% reduction). The risk of falling was further reduced (i.e., 24% reduction) if the exercise intervention included specific balance and gait activities<sup>10</sup>. Five of the seven study sites included community-residing older adults while two sites recruited participants residing in institutional settings. In the case of the community-based sites, participation was not based on a history of falls, identified impairments in balance or gait, or other specific fall risk factors.

Subsequent randomized controlled trials conducted in community settings with older adults at different levels of fall risk have continued to provide support for the role of exercise in lowering fall risk and/or fall incidence rates. Group-based exercise programs that include activities specifically designed to address known risk factors (e.g., impairments in balance and gait, muscle weakness, movement speed, impaired activities of daily living) have been generally shown to lower fall risk and fall incidence rates significantly more than exercise programs that adopt a more general approach, particularly when the group of interest is at a higher risk for falls<sup>6, 8-12</sup>. In all cases, health care professionals or well-trained physical activity instructors with previous experience working with older adults delivered these programs.

Individualized exercise programs that have targeted specific physical impairments identified during an initial assessment have also significantly lowered fall incidence rates. These programs have generally been designed and supervised, at least initially, by physical or occupational therapists in the home setting<sup>13-14</sup>. Campbell et al. reported a significant reduction in the rate of falling in a group of older women (80 years and older) identified at high risk for falling. Participants received an individualized exercise program designed and initially taught by a physical therapist. During the intervention period, regular telephone follow-up was conducted to maintain the participants' level of motivation. Participants who agreed to maintain the exercise program for an additional year (71% of original group) continued to experience reduced fall rates over the course of the second year when compared to the non-exercising control group<sup>14</sup>.

An Eastern form of exercise known as tai chi has also emerged as a viable stand-alone exercise intervention that not only provides numerous health benefits but also appears effective in lowering fall incidence rates among certain groups of older adults<sup>15-16</sup>. Wolf and colleagues were the first to demonstrate tai chi's effectiveness in reducing both fear-of-falling and fall incidence rates (as much as 47%) over a four-month follow-up period in a group of community residing older women who participated in a 15-week group and home-based tai chi program. Li et al. recently provided additional support for the use of tai chi as a fall prevention strategy in a group of sedentary, community-residing older adults who participated in a six-month program<sup>16</sup>. In addition to demonstrating significant improvements in multiple measures of balance, physical performance, and fear-of-falling, older adults in the tai chi group experienced significantly fewer falls of any kind as well as injurious falls during the six-month follow-up period, compared to a

group who received a low intensity flexibility program. Although clearly an effective and low-cost method for reducing the number of falls among relatively healthy, albeit sedentary older adults, tai chi has not been shown to be effective in reducing falls when the older adults studied are frail or transitioning into frailty<sup>17</sup>.

### **Multifactorial Intervention Strategies with Exercise as a Core Component**

Given that more than 60% of all falls experienced by older adults residing in the community appear to be the result of an interaction among multiple fall risk factors<sup>18</sup>, it is not surprising that multifactorial intervention strategies that include exercise as a core component, constitute the most effective method for reducing falls<sup>19</sup>. The primary goal of these types of strategies is to first identify and then minimize the fall risk factors identified using a systematic follow-up process. The most common fall risk factors that studies exploring this type of intervention strategy have targeted include gait and balance impairments, muscle weakness, number and type of medications, cardiovascular risk factors, vision, and environmental hazards in the home.

One of the first studies to examine the efficacy of a multifactorial approach to reducing falls was conducted by Tinetti and colleagues in 1994<sup>20</sup>. Men and women living in the community with at least one risk factor associated with falling participated in a multifactorial intervention that focused on medication adjustment, exercise, and behavior modification. Their results indicated that fewer participants in the intervention group, when compared to a control group that received usual health care and social visits only, fell during the one-year follow-up period (35 versus 47 percent, respectively). Close et al. also demonstrated a significant reduction in falls in the year following discharge from a hospital emergency department in a group of higher-risk older adults who received a

post-fall multifactorial fall risk assessment and appropriate referral and follow-up<sup>21</sup>. Only 32 percent of the intervention group versus 52 percent in the control group who received usual care reported at least one fall during the follow-up period.

A more recent study compared the effectiveness of a multifactorial intervention strategy in reducing fall incidence rates among healthy older adults (70 years and older) residing in the community<sup>22</sup>. The individual and combined effectiveness of three a priori selected strategies, group-based exercise, home hazard management, and vision improvement was compared. The 15-week group exercise intervention, supplemented with a home exercise program, proved the most beneficial single fall reduction strategy, with an estimated reduction in fall incidence rates of 6.9% over the 18-month study period. A combination of all three strategies resulted in a further reduction (i.e., 14%), albeit modest, in estimated annual fall rates.

Multifactorial risk factor assessment and intervention strategies, usually including targeted exercise as a core component, hold promise for significantly lowering fall incidence rates and fall-related injuries, particularly when targeting high-risk older adults with normal cognition. The successful implementation of these programs requires a multidisciplinary team approach as well as the time and resources needed to identify all the individual risk factors contributing to heightened fall risk. Implementation also requires careful coordination and follow-up to ensure that the older adult receives the appropriate services and treatment in a timely manner, with progress monitored over the long term. The very limited research evidence that currently exists also suggests that multifactorial intervention strategies have the greatest cost effectiveness when older

adults identified at high risk for falls are targeted<sup>23-24</sup>. Definitive conclusions relative to this issue, however, will depend on additional research.

### **Translating Research into Practice: Designing Physical Activity Programs aimed at Lowering Fall Risk.**

Physical activities that stimulate the multiple dimensions of balance should be the foundation of any structured exercise program aimed at reducing fall risk. Activities designed to improve the older adults' ability to process and integrate sensory information, anticipate and/or react quickly and efficiently to changes in task demands and/or the environment, allocate attention appropriately, and perform multi-directional and segmental coordination activities in a controlled manner will be particularly important components of such a program<sup>25,26</sup>. Including whole body functional activities that focus on improving muscular endurance, strength, and power, particularly in the muscle groups that contribute to postural alignment and stability during gait (e.g., ankle, knee, hip, and trunk) are also important for maintaining a high level of physical function<sup>27</sup>. Finally, physical activities designed to improve aerobic endurance should also be included in any physical activity program aimed at reducing fall risk. In addition to making it more difficult to complete tasks of daily living<sup>28</sup>, poor endurance levels will also lead to impaired functional ability, lower levels of physical activity, and the eventual loss of functional independence<sup>29</sup>.

*The Role and Type of Physical Activity is Related to the Level of Fall Risk.* For older adults at low risk for falls (i.e., no history of falls in previous year, absence of known risk factors for falls), physical activity serves a primary role in preventing the onset of disability. Not only does regular participation in physical activity yield important health

and performance-related benefits it can protect the older adult from a number of chronic diseases (e.g., heart disease, diabetes, cancer) and the onset of disability by helping them maintain their level of physical capacity above critical “thresholds” needed to perform every day activities independently and efficiently<sup>30</sup>.

At this level of fall risk, many physical activity choices are available to the older adult based on their interests and skill level. One of the simplest and least resource-intensive physical activities in which the majority of older adults can participate is walking. Engaging in a daily walking routine of moderate intensity at least 30 minutes a day will help an older adult maintain adequate levels of strength, aerobic endurance, dynamic balance, and coordination. Regular walking (at least eight city blocks or approximately 1600 meters per week) has even been shown to positively influence mobility levels among older adult women with functional limitations<sup>31</sup>. Walking has also been identified as the physical activity of choice among ethnically diverse older adults and may therefore serve as an important basis on which to build fall risk reduction programs aimed at culturally diverse groups of older adults<sup>32</sup>.

Balance can be effectively challenged during a walking program by manipulating both the environmental and task demands associated with the activity. For example, incorporating walking activities on different surfaces (e.g., grass, sand, chip or bark trails), with varied elevations, and or while holding light hand weights or using walking poles can make the task of walking more challenging while also raising the level of intensity required. Older adults who feel less stable when walking or are fearful of falling may also benefit from the use of walking poles to improve their overall level of stability. Incorporating different gait patterns (e.g., longer strides, narrow walking, zig-



zag walking) and/or variations in gait speeds can also add variety to the walking routine and specifically target balance and coordination.

Participating in well-rounded group exercise classes that include aerobic endurance, muscular strength, endurance and power, flexibility, and balance activities also lead to significant improvements in fitness and reduced fall risk. In addition, group-based classes provide a socially supportive activity environment and a level of supervision and structure that many older adults need in order to remain engaged over the long-term. Other recreational activities that incorporate many of the important functional parameters listed above include tennis, golf (combined with walking versus riding around the course), bicycle riding, and different types of dancing to music (e.g., ballroom, line dancing).

Some research support currently exists for the benefits of alternative forms of exercise such as tai chi as a stand-alone strategy for reducing fall risk among older adults at relatively low risk for falls. Certainly the development of tai chi programs in community settings has a number of advantages. Tai chi requires no equipment, can be performed indoors or outdoors, and can be performed in a group or individually in the home. Although tai chi programs are easy to initiate in community-based settings, careful consideration must be given to the form of tai chi selected and the qualifications of the instructor hired to lead the class. The Li et al. study selected the Yang style of tai chi and reduced it to 24 different movements that emphasized multi-directional weight – shifting, multi-segmental (arms, trunk, legs) coordinative movements, awareness of body alignment, and synchronized breathing<sup>16</sup>. In the earlier study conducted by Wolf et al., a simplified form of tai chi consisting of 10 exercise forms that “emphasized all

components of movement that typically become limited with aging” (p. 490) was used<sup>15</sup>. Movement components emphasized the gradual reduction in base of support, increased body and trunk rotation, and reciprocal arm movements.

Not all styles of tai chi may be appropriate for use with older adults. First, providers may need to manipulate the number and type of movement forms selected, for reasons of safety and ease of learning. Second, appropriate use may depend on the qualifications of the tai chi instructor who leads such programs. An experienced tai chi instructor who demonstrates a good understanding of the aging process and has the ability to adapt certain tai chi forms to accommodate common age-associated neuromuscular and orthopedic conditions will more likely have success than tai chi instructors, albeit very experienced ones, who have less knowledge about the aging process.

For older adults identified at moderate risk for falls (i.e., history of 1-2 falls in previous year, presence of one or more known risk factors for falls, including comorbid medical conditions), physical activity serves a secondary role by slowing the progression of disease and/or system impairments that limit an older adult’s ability to perform many daily activities independently. The research described earlier in this paper suggests that this group of older adults will derive more benefit from participating in physical activity programs that systematically target the identified risk factors. At this level of risk, programs need to be more tailored to the individual needs of participants and incorporate specific balance and gait activities, coupled with functional activities designed to improve muscular strength, endurance, and power. Activities should specifically focus on improving dynamic postural control in changing sensory environments and while

performing tasks of increasing complexity. Just as the principle of progressive overload applies when exercising the cardiovascular and musculoskeletal systems, it is just as important to systematically and progressively challenge an individual's balance abilities. Performing increasingly challenging balance activities (e.g., balancing or walking while performing a second task) is also likely to have a positive influence on essential cognitive processes (e.g., attention, memory, problem-solving)<sup>33</sup>. Observable improvements in balance and mobility also positively influence the individual's level of self-confidence and more global fear-of-falling. Whether this type of program is implemented in a group-structured setting or as a home-exercise program does not appear to influence the outcomes. A significant reduction in fall risk and/or fall incidence rates has been shown in both types of settings<sup>11-14</sup>.

Individually-tailored exercise programs that target known intrinsic risk factors also appear to be most effective for frail older adults who are advanced in age (> 80 years) and at high risk for falls (i.e., injury-related fall within past six months, presence of two or more risk factors associated with falls, including co-morbid conditions that are less medically stable). A health-care professional who can tailor the type of exercise to the specific needs and abilities of the individual generally supervises these types of programs. The initial focus in these types of exercise programs should be on strengthening all major muscle groups in a seated or supported standing position until sufficient strength permits the inclusion of unsupported standing exercises that emphasize dynamic balance and mobility. In addition to the improvements in physical capacity gained, these programs also positively impact the individual's perceived quality of life. For older adults at high risk for falls, physical activity serves a tertiary role by raising

their physical capacity to a level that will allow for greater independence in the performance of essential activities of daily living (i.e., dressing, bathing, transfers) and require less assistance with more advanced activities of daily living (e.g., shopping, walking in the community, assorted household chores).

Just as the type of exercise recommended changes as the level of fall risk increases so too does the intensity of the intervention strategy needed. In addition to a carefully tailored exercise program, older adults identified at high risk for falls are likely to derive greater benefit from a multifactorial intervention strategy that begins with a comprehensive medical screening for the purpose of identifying the specific fall risk factors contributing to each individual's heightened fall risk. Subsequent intervention strategies will be based on the results of the initial screening and may include referral to health care providers for treatment of chronic medical conditions, medication reviews, vision assessment, training in assistive device use, home assessment and modification, and fall risk education aimed at changing behavior.

### **Initiating and Maintaining a Physical Activity Program**

Despite the well-known benefits of physical activity, the majority of older Americans are physically inactive. National statistics indicate that only 31 percent of adults aged between 65 and 74 years and 23 percent of those 75 years and older are physically active on a regular basis (i.e., 20 minutes of moderate activity, three or more days per week)<sup>34</sup>. What factors appear to influence whether an older adult will or will not participate in a physical activity program? According to Schneider et al.<sup>35</sup>, older adults are more likely to participate in a physical activity program if they perceive that it will have health and psychosocial benefits. For example, older adults are more likely to

participate if they think the program will help them regain lost physical abilities, improve on or maintain existing abilities, and/or help them better control an identified disease (e.g., arthritis, cardiovascular disease). They are also more likely to participate if the program is enjoyable, provides opportunities for socializing with others, motivates them to continue coming, and if they believe that being physically active is good for them. Features of the program also influence the older adults' desire to participate. The level of guidance and supervision provided in a physical activity program, as well as access to information that would help participants learn more about their own health have also been identified as factors influencing participation. Schneider et al. also found that whether the program sounded interesting to the older adult and its associated cost were two additional factors that influenced participation. In contrast, the authors found that competing commitments (e.g., primary support provider, other service-related activities) and doubts about whether they could perform the activities or benefit from them were reasons provided for not participating in a physical activity program. Negative impressions of the program (e.g., non-exercise requirements, lack of flexible scheduling, and dissatisfaction with the staff involved in the program) also contributed to non-participation. McAuley et al.<sup>36</sup> have also demonstrated that compliance appears to improve if group-based physical activity programs include behavior change strategies designed to elevate self-efficacy and foster social support for exercise. Fostering the development of self-regulatory skills (e.g., goal setting), self-monitoring of progress and self-reinforcement have also been found to be effective strategies for increasing an individual's adherence to individualized home exercise programs<sup>37</sup>. The older adult's initial level of frailty and overall risk for falls appears to further influence the long-term

success of unsupervised home exercise programs<sup>2</sup>. Achieving long-term compliance in this higher risk group may require the addition of incentives and/or motivational strategies (e.g., regular telephone calls, in-home visits by an appropriately trained volunteer, tangible rewards) to foster long-term compliance to some type of physical activity program.

### **Summary**

A review of the existing research confirms that physical activity has an important role to play in preventing and/or lowering an older adult's risk for falling in community and home settings. Less evidence currently exists to support the efficacy of physical activity in reducing falls among very frail older adults living in long-term care facilities. For healthy older adults at low risk for falls, engaging in a broad range of physical activities on a regular basis is likely to be sufficient to substantially reduce the risk for falling. In contrast, older adults at moderate risk for falls will benefit more from engaging in structured exercise programs that systematically target the risk factors amenable to change and are progressed at a rate that is determined by the individual's capabilities and previous experience with physical activity. Finally, older adults identified at high risk for falls will benefit from an individually-tailored exercise program that is embedded within a larger, multifactorial intervention approach. These more resource-intensive approaches begin with a focused fall risk assessment aimed at identifying key risk factors (e.g., type and number of medications, cardiovascular abnormalities, environmental modification, depression, risk-taking behavior) that are amenable to intervention.

Finally, because long-term adherence to any type of physical activity is critical for long-term reduction in fall risk, designing physical activity programs that appeal to older

adults from diverse cultural and socio-economic backgrounds will be important.

Including a behavioral counseling component in any physical activity program will also be critical so that the older adult can begin to develop the necessary self-regulation (e.g., goal setting) and self-monitoring of progress skills needed to make physical activity a regular part of their daily lives.

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