Review Article

PHYSICAL ACTIVITY FOR ELDERLY PERSONS WITH NEUROLOGICAL IMPAIRMENT: A REVIEW

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The paper reviews studies conducted on physical activities and exercise in elderly persons with neurological impairment due to stroke, Guillain-Barre syndrome, Parkinson's disease, multiple sclerosis or post-polio syndrome. The paper concludes: (i) it is not possible at present to draw conclusions regarding persons with Guillain-Barre syndrome and Parkinson's disease; (ii) individuals with multiple sclerosis and post-polio syndrome benefit from physical activity, but all studies have so far been conducted on those under 65 years of age, and its effect on elderly persons with these diseases is not known; (iii) exercise and customary activities (walking and swimming) should be encouraged and promoted in elderly persons after stroke.

Key words: exercise, physical activity, elderly persons, neurological impairment.

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INTRODUCTION

Elderly persons aim to maintain independent function as long as possible. This depends on muscular strength and mobility and requires adequate physical fitness and a functional gait.

With advancing age, muscular strength declines (1) leading to a decrease in motor ability and a reduction in spontaneous physical activity. This in turn causes muscular strength to deteriorate further, resulting in a lower level of physical activity and creating a spiral model of decline, in which muscle strength plays a significant role (2). Eventually, muscle strength may decrease below the level required for standing up, walking at a given rate and climbing stairs. This results in difficulties in gait and balance, increased risk of falls and limitations in performing basic and instrumental activities of daily living (ADL). It has been shown that those dependent in ADL had lower scores in maximum walking rate, knee extensors strength, stair climbing capacity and forward reach, compared to those who were independent in ADL (3).

Muscular weakness of elderly persons may be preventable and partially reversible through exercise and activities such as walking (4, 5). Several studies reported in the literature indicate that knee extensors strength exercises lead to improvement in muscle strength (6); resistance and balance training achieved improvement in gait velocity (7), important for independent functioning (8); resistance training of hip extensors improved muscle strength and was accompanied by improvement in mobility and an increased level of spontaneous physical activity (9, 10); and strength and balance training reduced the frequency of falls (5, 10).

Physical activity also enhanced the performance of central nervous system functioning, leading to faster response times, better visual sensitivity and neurocognitive function (11). It also improved sleep in elderly persons (12) and promoted positive perceptions of psychological well-being (11).

What is the effect of physical activity in elderly persons who have identifiable neurological impairment rather than only frailty? Is it feasible and beneficial? Does it cause exposure to risks? Should it be promoted? This paper will attempt to answer these questions by reviewing studies on physical exercise and activity in two categories of neurological impairment in elderly persons: impairment that is the consequence of diseases whose incidence and prevalence increase with advancing age (such as stroke, Guillain-Barre syndrome, Parkinson's disease); and impairment caused by disease that appears at a younger age but, due to prolonged life expectancy, may be carried over as individuals age (such as multiple sclerosis, post-polio syndrome).

AGE-RELATED DISEASES

Stroke

The incidence rate of stroke (per 100000 of population) increases with advancing age: it is 104 for the 45–54 age group, 209 for the 55–64 age group, 681 for the 65–74 age group and 1113 for the 75–84 age group (13); 80% of strokes occur in people over the age of 65 (14).

Most stroke survivors have residual neurological impairments that persistently limit functions; one of the most important of these is hemiparesis, which causes walking disability: persons with hemiparesis walk more slowly at all rates of walking, are less capable of adapting the speed of their gait and possess a reduced range of walking speed, limiting their functional independence and ability to respond to environmental demands (15). The hemiparetic gait imposes increased energy expendi-

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ture which is of particular concern in elderly persons in whom advancing age and residual neurological impairment promote a sedentary life style that leads to declining cardiovascular fitness with low endurance to exercise. This is evidenced by high heart rate, respiratory rate and blood pressure responses to exercise with slow recovery and with high oxygen uptake (16), as well as by the failure of half of tested stroke survivors to complete a 6-minute walk, being able to walk only 250 m compared to the age-predicted distance of 600 m (17). This reduced endurance compounds the increased energy cost of the "hemiparetic gait" and may indicate the need for conditioning exercises.

Such exercises, under supervision and within patient tolerance, were found to be safe: 19 subjects (mean age 66), at least 8 weeks after stroke, were tested as to their responses to isometric hand grip, exercise with a cybex arm ergometer and cybex fitron cycle ergometer. Compared to matched control subjects, no significant difference was found in the two groups, except that work completed was higher for the control group. None of the experimental subjects reported dizziness, fainting or chest pain during exercise (18).

In another study, 19 subjects (aged 43–72) who had a hemispheric stroke at least 6 months previously and were mildly or moderately hemiparetic and medically stable, were compared to 23 matched, control subjects who did not have a stroke. All subjects had 30-minute sessions of aerobic exercise training on an adapted cycle ergometer, three times weekly during 10 weeks, in a humidity- and temperature-controlled laboratory environment, at the same time of day for each subject. The training increased maximal oxygen consumption, workload and exercise time, resulting in an attenuation of systolic blood pressure during exercise and a moderate improvement in sensorimotor function that was significantly correlated to the improvement in aerobic capacity (19).

In a more recent study (20), nine subjects who had had a stroke more than 6 months previously were given graded treadmill walking with the use of a hand rail and a support belt. The subjects (mean age 67 ± 2.8, range 58–85) were mildly or moderately hemiparetic and walked with a single point cane (two also had an ankle–foot orthosis), and had three 40-minute sessions weekly during 6 months. No serious adverse experiences that interfered with the training were observed. The training resulted in a 21% reduction of energy expenditure in the performance of a standardized walking task and there was a progressive decrease in heart rate. The study did not include control subjects. Another study performed in the same institution included 14 subjects with a mean age of 66 ± 3 who had had a stroke at least 6 months previously. They were given progressive, low to moderate task-oriented treadmill training to strengthen the quadriceps of the affected limb, for 40 minutes three times weekly during 3 months, resulting in an improvement in leg strength (21).

In another recent study, 15 stroke survivors (mean age 65.3, range 57–77) exercised on a bicycle ergometer with low repetitions of exertional pedalling (high workload); this increased the motor output in the affected leg (22).

Guillain-Barre syndrome

The incidence of Guillain-Barre syndrome shows a bimodal distribution, with a peak between the ages of 15 to 34, and a second, greater peak between 50 and 74 (23). Because of the latter peak, it may be regarded, partly, as an age-related disease.

Only one report was found in the literature relating to physical activity in Guillain-Barre syndrome. A 57-year-old person with residual deficits after the acute stage 3 years previously, underwent a 16-week supervised endurance training programme with an ergometer. He was able to increase his cardiopulmonary capacities, peak work level, total work capacity and isotonic leg strength. He also reported a subjective improvement in ADL performance as well as an increase in time spent on housework and gardening (24).

Parkinson's disease

The prevalence of Parkinson's disease (PD) increases with age. It affects 0.3% of individuals in the 55–64 age groups, 1.0% in the 65–74 age group, 3.1% in the 75–84 age group and 4.3 in the 85–94 age group (25).

The disease leads to a progressive loss of functional capability for independent living, with the main difficulties concerning mobility: bradykinesia, rigidity, tremor, shuffling gait, poor posture and balance. These may be partly corrected or compensated by rehabilitation interventions (physio- and occupational therapy) the effectiveness of which is generally accepted, particularly when it is provided in the form of intensive inpatient rehabilitation (26–28), and improves range of movements, coordination, balance and gait. These interventions have not included exercises directed towards increasing muscle strength or endurance.

One study performed on an ambulatory basis included 14 subjects (mean age 64.9) on anti-parkinsonian medication (which was unchanged during the study). They were divided into two groups: seven persons had stretching exercises and seven had upper body karate training. Both groups trained for 1 hour, three times weekly for 12 weeks. Six of seven subjects in each group showed improvement in coordination, gait and arm tremor (but not in rigidity or bradykinesia) as well as an increase in grip strength. Most subjects had feelings of improved well-being and more confidence in walking (29).

A more recent study of 16 individuals with mild to moderate PD (aged 47–60) who perform regular aerobic exercise showed that they may have the potential for maintaining their exercise capacity. Persons over age 60 as well as those with severe PD were not included (30).

DISEASES THAT ARE NOT AGE-RELATED

Multiple sclerosis (MS)

The incidence of MS is highest during the third and fourth decades of life, declining thereafter, with only less than 5% of cases occurring after the age of 40 (31). However, life expectancy of individuals with the disease has been prolonged.

Multivariate analysis of 695 veterans of World War Two with service-connected MS showed median survival from the year of onset to be 33 years for men and 42 years for women (32).

Active and passive range of movement and coordination exercises, as well as various facilitation techniques to induce voluntary motor activity or prevent complications have been recommended (33). The use of dynamic exercise (callisthenics, walking, cycling) for sustaining the physical conditioning response and for prevention of complications due to physical inactivity, have also been favoured (34). However, some activities—running, walking, cycling—may be inappropriate because of the exposure to harsh environmental conditions and the requirement for stamina and balance beyond the individual's capacities. The buoyant nature of water and the ability to control its temperature prompted the use of aquatic training programmes.

Eleven subjects (mean age 40) had three 1-hour sessions weekly during 10 weeks, consisting of shallow water callisthenics and free-style swimming, with water temperature regulated within the range of 24–27°C. At the completion of this course, subjects had an 82% increase in the total work measured for upper extremities and a 33% increase for the lower extremities; the peak torque for the lower extremities decreasing from 54 to 41%, i.e. an improvement which is significant for individuals with MS in whom fatigue is a universal symptom. The course caused no harm and all subjects completed it safely (35).

Individuals with motor alterations of the lower extremities and the trunk have characteristic gait parameters: short, quick steps and lack of a full range of motion, as well as an increase in the energy cost of walking, due more to spasticity than to muscle weakness (36). An aquatic exercise course had no effect on the gait parameters (37).

The increased cost of energy is a burden on the cardiorespiratory system and may limit walking performance. When deconditioning due to lack of exercise also exists, then the cardiorespiratory reserve is further compromised. In a recent study, 46 individuals with multiple sclerosis (mean age 41.1) were randomized into an experimental group (21 subjects) and a control group (25 subjects). Subjects of both groups continued their current life style and routine medical care. Experimental subjects also had supervised aerobic exercise three times weekly for 4 months, and showed an increase in maximal aerobic capacity and isometric muscle strength, and an improvement in body composition (i.e. reduced fat) and blood lipids. Depression, anger and fatigue were reduced, emotional behaviour improved, and social activities and recreational pursuits increased. No changes in the neurological impairment and no deleterious effects of the exercise were observed (38).

Post-polio syndrome

The average age of people who survived acute poliomyelitis is now, in the U.S., over 50 years of age, and more than 20% are in their sixties and seventies (39).

Some individuals who have had polio report easy fatigability, progressive weakness in muscles previously affected by the disease and also in muscles apparently unaffected by it. Many also have pain in muscles on walking. These individuals are said to have post-polio syndrome (PPS); their complaints of progressive decline in neuromuscular function of the lower limb musculature have been objectively demonstrated. Symptomatic PPS subjects (compared to control and to asymptomatic post-polio subjects) have a deficit in isometric strength and in work capacity, and a 10% deficit in the ability to recover strength after exhausting activity (40). Their muscle strength has been found to decrease over a 4-year period of follow-up (41).

The deficiency in the neuromuscular function causes difficulty in walking and stair climbing, as well as in social activities (42). A study of functional consequences of the syndrome in 41 persons under age 65 (mean age 54) showed that it had a substantial impact on instrumental ADL (43).

Twelve subjects with a history of polio (mean age 54, range 41–63) were given three sessions weekly of a combined isometric–isokinetic training programme on a cyclex II isokinetic dynamometer for 6 weeks. They completed the programme without discomfort or unfavourable side effects and showed an increase in isometric knee extension muscle strength, indicating that muscles affected by polio in the past can increase strength. Subjects who underwent the training reported easier performance of ADL, walking and stair climbing (44).

Seventeen post-polio subjects (mean age 42, range 39–50) underwent an endurance training programme without harmful short-term effects in their affected muscles. Their functional status changed both with increase in strength in some muscle groups and with lower submaximal heart rate at the same work load (45). Twelve post-polio subjects (mean age 51, range 43–62) underwent a combined dynamic and isometric 12-week muscle strengthening exercise programme. They attained an increase in neuromuscular function (muscle strength, endurance and isometric tension time index) without adversely affecting the muscles or the motor unit (as determined by measurement of serum creatine kinase and electromyographic variables) and without new complaints of weakness, fatigue or other adverse effects (46). Researchers in Göteborg, Sweden, found a relationship between the intensity of physical activity in daily life and in experience of pain, and suggested that individuals with aching and cramping pain attenuate their level of physical activity in daily life (47). They also studied 32 walkers (with or without a device), with a mean age 56 (range 22–65), exercising on a bicycle ergometer and found reduced capacity for exercise, perceived general fatigue and high level of effort during the test. They suggested that PPS individuals with weak leg muscles and low peak heart rate and oxygen intake could benefit from muscle training, focusing mainly on peripheral muscle endurance, while those with relatively good muscle strength, high peak rate and reduced maximal oxygen could improve their aerobic fitness in a general exercise programme (48). They also found that non-swimming, general fitness training in heated water had no ill effects on post-polio subjects (mean age 51, range 22–65). No change in the peak workload, peak oxygen intake or muscle strength or endurance were observed, but a decreased heart rate at the same workload was recorded and trainees reported improved well-being. Consequently, dynamic exercise in water was recommended (49).

DISCUSSION

The ageing process is usually accompanied by a progressive loss of aerobic power and muscle strength that may lead to a situation in which the minimum requirements of work, leisure or daily life can no longer be met. Neurological impairment imposes additional functional limitation and aggravates the course of events, leading to the inability to maintain independent functioning.

In frail elderly persons this course may be prevented and partially reversed by physical activity. The purpose of this paper was to determine whether physical activity might be beneficial also in elderly individuals with definable neurological impairment. The paper reviews studies conducted on the issue regarding the five most common diseases that cause the impairment in such persons: stroke, Guillain-Barre syndrome, Parkinson's disease, multiple sclerosis and the post-polio syndrome.

The literature on the effect of exercise and physical activity in elderly persons with neurological impairment is not abundant. Most of the studies involved small, or very small, samples of subjects and not all included control groups; therefore, their findings should be interpreted with caution.

It is felt that there is insufficient information to allow us to draw any conclusions regarding the impact of exercise and physical activity in elderly persons with Guillain-Barre syndrome or Parkinson's disease.

Studies on multiple sclerosis were conducted on young adults (mean age 40). Their findings suggest that exercise increases aerobic capacity and isometric muscle strength, and leads to a reduction of fatigability of the lower extremities. Thus, individuals with multiple sclerosis should be encouraged to engage in regular aerobic exercise and muscle strengthening. Under supervised conditions such exercise is not harmful and has a positive impact on factors related to the quality of life, unrelated to a modification of the neurological impairment. In the latter respect, the impact of exercise is similar to that of rehabilitation (50). However, it is necessary to study the effect of exercise on persons with multiple sclerosis who are over the age of 60.

Individuals with the post-polio syndrome seem to benefit from physical exercise without negative effects. However, studies were done mainly on persons under age 60, and the effect of exercise in older persons with the syndrome is unknown. Individuals who experience a high level of pain should attenuate their level of physical activity to that at which the pain does not occur.

With regard to stroke, a meta-analysis of 36 clinical trials indicated that focused inpatient rehabilitation was effective (51). However, on completion of a rehabilitation programme (that stresses optimization of ADL without providing aerobic exercise) elderly individuals do not attain the level of physical fitness that meets higher energy costs of walking and stair climbing. Many of them are physically deconditioned, experiencing fatigue, dyspnoea and weakness when attempting to walk outdoors or climb stairs. They therefore tend to avoid these activities, leading to further inactivity, depression and anxiety (14).

Conditioning exercises were found to be harmless and safe in elderly persons following stroke, and resulted in increased aerobic capacity with a reduction in energy expenditure. Task-oriented treadmill training resulted in improved leg strength. An improvement in sensorimotor function was observed, correlated to the improvement in aerobic capacity.

Since there is increased pressure to discharge patients from a rehabilitation programme as soon as possible to the community, it may be expected that many will be discharged in a deconditioned state. It would therefore be useful to set up community-based intervention to improve endurance, balance and strength. Because of the high cost of exercise programmes based on institutions, as well as because of the relative lack of suitable facilities and the cost of transport involved, it would be preferable to set up home-based interventions, possibly supervised by a therapist during its initial stage, and to encourage individuals to continue the exercises and physical activities on their own (52).

Physical activity should be encouraged in all elderly persons including those with neurological impairment. This particularly applies to impairment following stroke in which exercise and customary activities (walking, swimming) should be encouraged and promoted in elderly persons with stroke. These should be part of a long-term, comprehensive rehabilitation programme.

Persons with multiple sclerosis or the PPS benefit from physical activity and training, but it is not known whether this applies to elderly persons as well.

There is insufficient information to express opinion regarding physical activities in elderly persons with Parkinson's disease and Guillain-Barre syndrome.

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