THE EFFECT OF PHYSICAL TRAINING ON THE LOCOMOTOR APPARATUS IN ELDERLY PEOPLE

André Pedrinelli[1], Luiz Eugênio Garcez-Leme[2], Ricardo do Serro Azul Nobre[3]

ABSTRACT

Physiological changes taking place on the locomotive apparatus as a result of aging, such as muscular mass loss, body balance loss, reduced bone mass and osteoarthrosis cause limitations to the daily activities of elderly people, compromising their quality of life and making them weaker and dependent. Aged people who regularly practice physical activities have a higher level of functional independence and a better quality of life than the sedentary ones. This article addresses the key physiological changes with aging and provides a review of current literature about the effects of physical exercises on the locomotive apparatus of elderly individuals, specifying the best ways to prescribe physical exercises to this age group.

Keywords – Aging; Health of the elderly; Exercise; Motor activity

INTRODUCTION

The biological aging process determines changes in the locomotor apparatus that cause limitations to the activities of daily living and thus compromise the quality of life of aging people. The decrease in activity level may lead the elderly to a state of weakness and dependency. Current evidence shows that physical activity has health benefits for the elderly, maintaining functional independence[1] and improving their quality of life[2].

Population projections[3] estimate that the Brazilian elderly population will increase its relative importance from 5.4% in 2000 to 18.4% in 2050 and that the age pyramid will evolve in a process of narrowing its base, characterizing an aging population.

Among the complaints related to the musculo skeletal system, osteoarthritis (OA) is the most prevalent joint disease among individuals over 65[4]. Approximately half of the people over the age of 65 have OA, its prevalence increases to 85% for those over 80 years old[5,6]. Studies indicate that 27% of the population between 63 and 70 years have radiological signs of knee OA[7]. OA is a major cause of chronic disease and disability in the elderly population[8].

Loss of muscle mass is another important aspect to be addressed. The loss of muscle strength and power leads to a decreased ability to promote the rapid joint torque necessary to activities that require moderate force, such as rising from a chair, climbing stairs, and maintaining balance while avoiding obstacles. This, in addition to causing the individual to be increasingly dependent, can facilitate falls. Approximately 30% of people over the age of 65 and half of those over 80 suffer a fall each year[9]. The fall or the injury resulting from it can have a devastating effect on the independence of the individual and their quality of life. Among the consequences of falls, one can include musculoskeletal injuries (fracture of the proximal femur being the most serious), the subsequent fear of falling once again, the general decrease in the activities of daily living, functional deterioration, social isolation, the worsening of quality of life, institutionalization, and even death[10,11].

1 – Associate Professor, School of Medicine, and Assistant Physician, Sports Medicine Group, Institute of Orthopedics and Traumatology, HC-FMUSP.
2 – Geriatrician, Associate Professor, Department of Orthopedics and Traumatology, USP School of Medicine.
3 – Physician, Sports Medicine Group, Institute of Orthopedics and Traumatology, HC-FMUSP.

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Correspondence: Rua Dr. Ovídio Pires de Campos, 333, 3º and. – 05403-010 – São Paulo, SP. E-mail: pedrinelli@uol.com.br

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A fall associated with bone fragility characterized by osteopenia/osteoporosis may increase the likelihood of the elderly person suffering some type of fracture. Although hip fractures occur in only 1% of falls, it is responsible for much of the incapacitation, deaths, and medical costs related to treatment of the elderly[12]. The aim of this paper is to explain how physical activity can bring benefits to the musculoskeletal apparatus of the elderly and expose which exercises are usually indicated for this population in a review of the current literature.

PHYSIOLOGICAL EFFECTS OF AGING

The aging process is associated with loss of muscle mass (sarcopenia) and a corresponding reduction in peak force[13]. The loss of muscle mass begins at age 30, but increases around 50, even occurring in the athlete[14-16]. A phenomenon occurs in which contractile protein is replaced by intra- and extracellular lipids and structural protein[17]. Between 65 and 84 years, isometric muscle strength decreases approximately 1.5% per year, while muscle power decreases 3.5% per year[18]. The loss of muscle power is greater than the force lost due to selective loss of type II fibers (fast twitch). The decrease in muscle power determines the reduction of muscle contraction speed and this loss in the muscles responsible for maintaining orthostatic posture can contribute to an increase in the number of falls[19]. There is a neurological decrease in the number and size of motor units, which is also a primary cause of loss of muscle strength possibly modulated by the afferent signals of the joints involved (arthrogenic inhibition)[20].

The loss of the ability to retain water in the body due to aging, associated with a decreased capacity to produce proteoglycans, causes degenerative joint changes, since cartilage has a limited ability to absorb impact. This, associated with decreased joint stability, increasing muscle weakness and the physiological weight gain that occurs with age, is an aggravating factor of degenerative changes[21]. Proprioception also declines with age and some studies show that this loss also contributes to the development of OA[22,23], though the question remains whether the reduction of proprioception is the cause or consequence of OA[8].

There are changes in the resistance of the musculoskeletal system characterized by structural changes in the tendons, which become more rigid and therefore more likely to suffer microruptures or complete ruptures[24], and decreased bone mass caused by an imbalance between the activity of osteoclasts relative to osteoblasts, with higher consumption and/or less production of bone. In women, in the early postmenopausal years, the imbalance in this relationship is mediated by insufficient estrogen. Later, as calcium needs increase with age, its deficiency and deficiency of vitamin D become more important from an etiological standpoint. In men, it is caused by decreased levels of testosterone, which occur more slowly and gradually. Depending on the amount of bone loss, the elderly person may have osteoporosis, a disease characterized by low bone mass and deterioration of the microarchitecture of bone tissue, leading to a state of bone fragility and, consequently, an increased risk of fractures[25].

THE BENEFITS OF PHYSICAL ACTIVITY FOR THE ELDERLY POPULATION

When researching the literature on the impact of regular physical activity on the locomotor apparatus in the elderly population, we mainly found studies evaluating the effect of exercise on body balance in the elderly individual and in the population with OA. In relation to osteoarthritis, studies conclude that physical training has no impact on the pathophysiological process of the disease[26-29] and that it is effective in controlling pain and improving function in the elderly[30]. As for balance, the studies relate physical activity to an improvement in postural and gait stability in the elderly, which can reduce falls in this portion of the population[31,32].

Systematic reviews evaluating the effects of exercise on people with OA have concluded that there are benefits in relation to pain and function in the elderly, however, the magnitude of the effect varies and they do not explain which types of exercises would have the greatest effect. The systematic review by Fransen and McConnell[33] concluded that physical activity on the ground has a small but significant effect in improving pain and function in elderly patients with knee OA and it is comparable to the benefits of using common analgesics and non-hormonal anti-inflammatory drugs. In the same study, no significant differences were found between aerobic exercise and muscle strengthening in improving pain and function; yet supervised exercise (both individual and group classes) was found to

have a greater effect in controlling pain than unsupervised exercise. Finally, we conclude that specific recommendations on the training program (intensity, volume, frequency, progression and duration) cannot be made, because there is no study that specifically assesses these variables. Roddy et al.[34] performed a systematic review comparing walking aerobics and localized muscle strengthening and found that both reduced the pain and disability caused by OA, with no statistical difference between them; in the end, they stress that there is great variability in the duration of training programs in the various studies evaluated (eight weeks to two years). The study by Woodard and Berry[35] states that a long time of compliance is necessary for the exercise program to maintain the benefits that physical activity provides, and that the motivation that regular monitoring and supervision provides may be an alternative for maintaining elderly adherence to treatment. A meta-analysis by Hernández-Molina et al.[36] and a review by Tak et al.[37] evaluated the effects of exercise on hip OA and concluded that physical activity is effective in treating pain, highlighting the need for muscle strengthening in exercise programs. Finally, a review by Bartels et al.[38] investigated the benefits of aquatic exercise in the treatment of knee and hip OA, and concluded that this type of exercise has short-term beneficial effects for pain and function; the long-term effects were not documented in the reviewed studies. Thus, exercise in water should be used as the initial part of a longer exercise program for the patient with OA.

Several studies have shown that exercise training has significant effects on muscle mass and on the strength developed in muscles[39-43]. In the elderly individual, it is clear that muscle power, not strength, is the determining factor for improving independence and quality of life[44,45], besides being a better indicator of risk prevention for falls[46]. Thus, for the elderly, it is necessary for muscle strengthening to be done at high intensity. Some studies with low-intensity strengthening resulted in increased muscle strength[11,47], but with no or very little effect on the health of the elderly[48,49]. Although muscle strengthening lead to improved function, other more functional exercises are required for greater gains in the balance and independence in the elderly[11,12]. Orr et al.[50] conducted a systematic review that evaluated the efficacy of progressive muscle strengthening on body balance, and suggested that this type of training performed alone is not effective for improving balance, adding that other factors are involved in postural stability. Skelton and Beyer[12], when conducting a literature review, concluded that a training program to reduce the risk of falls and fractures should include balance, coordination, and reaction time exercises, in addition to muscle strengthening; and that training containing only weight training or walking are less effective for postural stability. However, in a systematic review, Howe et al.[51] affirm that several types of exercises provide benefits to body balance, even if performed in isolation. These physical activities include functional exercises (for balance, gait, and coordination), muscle strengthening, walking, dancing, tai chi chuan, cycling (both stationary and free), the latter showed a tendency to improve only body balance. However, they caution that all of these interventions only have short-term effects and that standardized long-term studies should be performed to evaluate the effect of regular physical activity on postural stability.

Some forms of exercise have been shown to be beneficial in delaying or reversing the bone loss associated with age[52]. These activities include: weightlifting exercises[53], running[54], and classes in gyms[55]. Isolated walks do not increase bone density, though they help to maintain it[52]. In their study, Nakatsuka et al.[56] showed that physical activity of moderate intensity can increase bone mass after menopause. However, the gain was modest and specific to certain regions of the body. In a systematic review, Bonaiuti et al.[57] evaluated the effects of different types of physical activity in preventing and treating osteoporosis in women with menopause. The results showed that there is evidence that physical exercise is effective in reducing loss of bone mass in the lumbar spine, and probably at the femoral neck and the wrist. Aerobic exercise, strength training, and walking made a significant difference, however, the authors caution that there were no conclusions as to which feature of the exercise (type, intensity, frequency, or duration) most benefits bone mass or whether or not this benefit persists after cessation of physical activities. Korpelainen et al.[58], in a randomized, controlled population study, concluded that physical exercises had a positive effect, especially in trochanter bone mass, and may prevent fractures related to falls in elderly women. Karinkanta et al.[59] found that the exercise-induced

benefits in dynamic balance and tibial bone mass persist one year after the end of physical activity, although muscle strength and physical function do not.

PRESCRIPTION

As discussed earlier, the optimal combination of exercises to improve locomotor apparatus function in the elderly is still unknown. There is currently only a little empirical support for combining strength training with other modes of training (aerobic exercises, balance, and coordination). The intensity, duration, frequency, and progression of the training program are also debatable, and studies with designs better suited to evaluate these variables are needed. Below, we mention the prescription of exercise in the elderly according to some consensus found in the literature:

1) Pre-participation evaluation

Contraindications are present in table 1, but in general do not differ from those applied to young adults[60]. The need for exercise electrocardiography is contradictory, it should be considered for patients with cardiac risk factors.

2) How to start

The exercises should target the improvement of the functional limitations that the elderly will experience (pain, reduced range of motion, or muscle weakness). Once there is improvement of these limitations, a general conditioning program should be created in order to improve the health and functional capacity of the individual.

The workouts should include three phases: warming up, which involves low intensity exercises to gain range of motion in the joints; the training period (the effort itself), which involves muscle strengthening and/or aerobic exercise; and the final phase which basically covers stretching (cool-down).

3) Stretching

Stretching should be performed during the warm-up and the final phase. Large range of motion (ROM) of the joint increases muscular performance[61], reduces the risk of injury[61,62], and improves the nutrition of the cartilage[63]. Painful joints should not be stretched excessively to the point of causing pain, and all movements should be made in order to achieve the maximum pain-free ROM. The application of heat before stretching reduces pain and increases range. At least three stretching sessions should be performed per week[64], with three to five repetitions at first, gradually increasing to 10 repetitions[65]. Each muscle stretch should be held for 10 to 30 seconds.

4) Muscle strengthening

Muscle strengthening should be accomplished by using weights or elastic bands that provide resistance to movement. The training protocols should include the following principles:

– Muscle contraction exercises should be done at moderate speed;
– Exercises should be chosen according to the stability of the joints and the degree of pain and swelling;
– The muscles should not be exercised to the point of fatigue;
– Submaximal weights should be used in the exercises;
– Joints with inflammatory reactions should be strengthened with isometric exercises and involving few repetitions at first;
– Joint pain or swelling after one hour of exercise indicates excessive activity.

Isometric exercises are recommended for unstable or swollen joints. Isometric contractions produce low pressure on the joints and are well tolerated by elderly patients[66]. It should begin with a contraction intensity of approximately 30% of maximum strength, increasing gradually to 75%. The contraction should not be held for more than six to 10 seconds and repetitions should be increased to eight to 10 as tolerated by the patient. These should be performed twice a day during the inflammatory period, and after the inflammation recedes, increased from five to 10 times a day.

Isotonic exercises should be eight to 10 exercises involving the larger muscle groups (four exercises for the upper limbs and four to six for the lower limbs). Initially, weights with 40% of the maximum load for the individual should be used, increasing up to 80%[67,68]. Generally, a series of four to six repetitions is performed, avoiding muscle fatigue. The frequency should initially be twice a week at most[8], or even only once in elderly persons of advanced age or significant fragility. There must be at least one full day of rest between sessions[69].

5) Aerobic exercise

The patient can choose from a variety of exercise options, avoid overloading specific joints. Examples of exercises are: cycling, swimming, low-impact exercises (walking, dancing, tai chi chuan), hydrotherapy, and even lighter activities such as walking a dog and/or playing golf. Exercise intensity can be measured by the heart rate during exercise, which should be between 50 and 75% of the maximum heart rate (calculated as 220 minus age), or a talk test, which is considered positive when the patient cannot talk comfortably during physical activity due to the change in respiratory rate. Starting with at least 20 to 30 minutes per day is recommended, during the week, the total should be between 60 and 90 minutes of moderate activity[8]. The frequency must be at least three and no more than four times a week.

6) Caution

The person with postural instability or a history of injuries from falls should be referred to physiotherapists, occupational therapists, or qualified physical trainers for this type of work (postural rehabilitation and correction of postural imbalances)[69]. Tendinitis, bursitis and back pain may occur in the elderly when the strengthening is carried out in an exaggerated manner.

CONCLUSION

The locomotor apparatus changes that occur as a result of aging that cause loss of balance, bone fragility, joint pain, and decreased function can be minimized through regular exercise.

While many doubts remain as to how best to prescribe and guide physical activity, there is an increasing tendency to combine aerobic exercise with resistance exercise (muscle strengthening). Exercise programs must be tailored according to the specific needs of the elderly individual. Long-term adherence to the proposed program is needed to maintain the benefits gained from physical activity.

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