Sarcopenia, mobility and balance: the importance of physical exercise

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Sarcopenia refers to a decrease in muscle mass and function with advancing age. The muscular strength and power of the lower limbs is diminished to a greater extent than muscle mass. This deficiency is the result of multiple factors, including dwindling use (immobilization), hormonal changes, disease and chronic inflammation, insulin resistance and malnutrition. It is generally acknowledged that, of the measures for prevention and treatment, physical exercise is effective in increasing muscle strength and to a lesser extent, muscle mass.

EXERCISE AND PHYSICAL ACTIVITY

The concept of physical activity denotes any bodily movement produced by skeletal muscles in conjunction with an increase in energy expenditure above resting level or an increase in heart rate. By contrast, in exercise, movements are planned, structured, repetitive, and purposeful with the aim of improving or maintaining physical fitness or functioning.

“Moderate” physical activity is distinguished from “intense” or “vigorous” physical activity.

There are also various types of exercise. Endurance or “aerobic” exercise is a medium intensity activity over an extended period, featuring rhythmic and repetitive movements. Walking, jogging and water-based exercise are typical aerobic activities. In “resistance” activities, muscles must work against a force such as a counterweight or elastic bands. Small numbers of repetitions of these exercises are undertaken in a short space of time. “Stretching” exercises, such as yoga, involve muscle and connective tissue, which are stretched to improve and/or maintain the range of motion. “Balance” exercises are based on dynamic movements that alter the centre of gravity, postures that reduce the base of support and walking on an unstable surface, to improve balance.
**IMPACTS OF PHYSICAL EXERCISE**

Physical exercise exerts an influence on all the body's systems: on muscle, of course, but also on the heart, the brain, and hormone secretions. Insufficient physical exercise may lead to organ failure [1].

The primary objective of physical exercise is to improve muscle strength and power, i.e. the strength that can be deployed per unit of time. Different types of exercise develop one or both.

Physical exercise also aims to improve physical performance as measured by various tasks such as the gait speed test, the short physical performance battery, the stair climb power test, the 6-minute walking test, and the timed get-up-and-go test (TUG), etc.

These tasks measure muscle strength and power. They are of interest because of their capacity to reveal changes in muscle function earlier than the measure of muscle mass alone. Numerous studies have shown that the age-related loss of strength and power is more pronounced than the loss of muscle mass. Thus, the US 3-year longitudinal Health, Aging and Body Composition Study of 1880 subjects with an average age of 73 years showed that up to 12% of muscle strength could be lost, for a loss of mass of just 7% or so (see fig. 1) [2]. This study also showed that the age-related loss of power is even more pronounced than the loss of muscle strength [3].

![Figure 1](image_url)

**Figure 1.** Development of muscle mass and strength in elderly subjects over 3 years, by gender and changes in body weight [2].
Changes in muscle mass and strength were determined in 1880 elderly individuals. Knee extensor strength was measured using isokinetic dynamometry. Lean mass was measured using dual-energy absorptiometry and computer-assisted tomography. Muscle strength decreased much more rapidly than the concomitant loss of muscle mass.

WHAT IS THE EVIDENCE FOR THE BENEFICIAL EFFECT OF EXERCISE?

A widely accepted dogma considers that physical exercise and activity are good for bones, muscle and various organs such as the heart. However, well-conducted studies do not always manage to show these benefits clearly in the elderly. Some of these studies showed that resistance exercise produced similar improvements in muscle mass and strength in both young and elderly subjects, while others show better results in the younger group.

Ultimately, a meta-analysis of these studies by Cochrane identified a difference of just 12% between the groups that had followed a physical exercise programme and the control groups.

The heterogeneous nature of the studies and their content has led to uncertainty regarding the degree of evidence that supports the beneficial effect of physical exercise on muscle strength and mass:
- cross-sectional or longitudinal observational studies, or controlled intervention studies;
- type of intervention or independent variable;
- population (normal or sarcopenic);
- age at intervention;
- duration of intervention, reversibility of the effect measured;
- compliance;
- variable studied (muscle mass, strength and power, or walking speed or falls, which may also involve coordination or balance);
- presence of confounding variables (nutrition, hormonal status or treatment, obesity, social condition, cognitive function, osteoarticular damage or metabolic changes).

Thus, the duration of randomized controlled tests varies from 10 weeks to 18 months for groups of 23 - 246 subjects. A variety of exercises are used. The development of muscle parameters after the end of the intervention is rarely quantified or documented.

DEMONSTRATED EXAMPLES OF A BENEFICIAL EFFECT

A variety of initiatives have, however, revealed a clear benefit to elderly and even very elderly people following a physical training programme. For example, the
Fiatarone study, which led the way in this field, included 100 subjects who undertook 45 minutes of lower limb resistance exercise each day in association with nutritional supplements. Significant difficulties of implementation were experienced in respect of this study, given an average age of 87 years for study subjects (who ranged from 72 to 98 years), with a follow-up period of 10 weeks. Ninety-four patients completed the study. Their muscle strength had almost doubled, walking speed had increased by almost 10% and power as assessed by the stair climbing test had risen by 24% (see fig. 2) [4].

![Bar chart](chart.png)

**Figure 2.** Average increase in muscle strength further to an exercise programme and nutritional supplements [4].

The bar chart shows the average change in the strength of trained muscles compared with the value on inclusion. The impact of exercise was significant after adjustment for age, gender, functional status, muscle strength on inclusion and hypertension.

A further study of a small number of subjects (active treatment: n = 11; controls: n = 12) aged between 85 and 97 years examined the impact of 12 weeks of progressive resistance exercise. Training sessions increased isometric knee extensor strength by 37% and isokinetic knee strength by 41 – 47%. Biopsies showed hypertrophy of fast-twitch, type II muscle fibres, while there appeared to be less of an impact on slow-twitch, type I muscle fibres [5].

Finally, it would seem that functional performance and incapacity are more closely associated with muscle power than with muscle strength. Fast resistance training improves muscle power and functional development more effectively than slow resistance training.
DO THE BENEFITS TO YOUNG AND ELDERLY SUBJECTS DIFFER?

Why do physical training programmes appear to provide less of a benefit to elderly subjects than to younger subjects?

The decrease in protein synthesis with increasing age is a primary factor in decreased effectiveness. The comparison of muscle protein synthesis in response to physical exercise shows the existence of anabolic resistance in elderly patients [6]. Similarly, it has been shown that for the same quantity of orally administered amino acids, elderly people will show reduced myofibrillar protein synthesis in comparison with young people (see fig. 3) [7].

The patient's condition at the start of a physical exercise programme also appears to have an impact. A study of 188 frail subjects with an average age of 75 years, who had taken part in a 6-month home-based physiotherapy programme, showed that subjects with moderate frailty benefited from the programme while there was no effect for severely frail subjects (see fig. 4) [8]. It therefore seems unrealistic to hope that very frail patients will derive benefit from a physiotherapy programme, if only because they may not be capable of performing the required exercises.

A third factor that reduces effectiveness is diet. Only when subjects consume more than 1.1 g of protein per kilogram of body mass is the benefit of a physiotherapy programme evident in terms of an increase in lean mass, measured using dual-energy absorptiometry. It is therefore important that subjects' diet is adequate in order for the effect of physiotherapy to be detected [9].

![Myofibrillar protein FSR (%·h⁻¹)](image)

**Figure 3.** Muscle protein synthesis in relation to age. Fractional rate of synthesis (FRS) [7]. Comparison of rates of myofibrillar protein synthesis in the vastus lateralis muscle (determined using the temporal profile of marked intracellular leucine) based on subject age (young average: 26 years; elderly average: 70 years) and the dosage of orally administered amino acids.
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**Figure 4.** Average incapacity at baseline and after 3, 7 and 12 months of a physiotherapy programme in moderately or severely frail patients [8]. Results in the treatment and control groups are reported as average incapacity scores. Negative binomial models were used to calculate the results, adjusted for the means of recruitment (based on consultation or records), physical frailty (graph A only) and the incapacity score on inclusion.

**RECOMMENDATIONS FOR THE ELDERLY**

Various organizations have issued recommendations for the elderly. For example, the American College of Sports Medicine and the American Heart Association recommend 30 – 40 minutes of moderate aerobic physical exercise or 20 – 30 minutes of vigorous exercise each day, plus strength exercises such as getting out of a chair and flexibility exercises on at least 2 days every week. Balance exercises are recommended if the patient is at risk of a fall or has already had a number of falls. It is acknowledged that it is no straightforward matter to advise this type of training programme to the over 80s sufficiently convincingly to secure their long-term adherence, and that there are questions regarding the feasibility of following such recommendations.

**Music-based multitask exercises**

However, there is a need for effective strategies to prevent sarcopenia in elderly patients. “Jaques Dalcroze” eurhythmsics may be an interesting alternative. This is a musical education method developed in Geneva at the start of the 20th century, based on music, movement and improvisation. It consists of dissociated movements of the lower and upper limbs, performed in time to improvised piano music. It engages the elderly individual in a new form of physical exercise, which promotes a strong link between movement and music and involves balance and walking, coordination, concentration and memory.

A randomized, controlled trial conducted in Geneva with subjects aged 65 years and over who had experienced a fall or who had a balance disorder, shows that this
practice improves single or dual-task walking and balance, and that it reduces the risk of falls in high-risk subjects. While this study was not directly concerned with the prevention of sarcopenia, the results show that Jaques Dalcroze eurhythmics may also be of benefit in mitigating the consequences of this disease, i.e. gait disorders.

Subjects trained for 1 hour a week for 6 months. The trial was conducted in rotation, i.e. control subjects received teaching throughout a second period of 6 months while the subjects treated previously did not.

After 6 months of practice, variability in gait was considerably reduced. A significant positive impact persisted 6 months after stopping. Improvements were also seen in function as evaluated using the TUG, balance measured using the simplified Tinetti test and the duration of the one-foot balance test, and the angular speed of movements measured using accelerometers placed at the back of the subject. The incidence of falls decreased by almost 50% [10].

The social aspect of this fun, friendly approach must also be highlighted, given its contribution to the continuing interest in this form of physical exercise.

CONCLUSION

In most studies, physical training programmes produce positive results. The effectiveness of implementation will depend on the type of exercise and the frequency of sessions, as well as the level of compliance with these programmes. Only those interventions combining long-term effectiveness and acceptability are likely to have a positive effect on sarcopenia in the elderly.

Bibliography

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