Physical activity, muscle mass, and muscle function

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Physical inactivity is strongly related to development of chronic diseases, including sarcopenia.[1] Age-related sarcopenia is characterized by a progressive decline in muscle quantity and quality leading to diminished strength, power, and endurance in older people (Figure 1).[2] Loss of muscle may be accompanied by a gain in fat mass. People experiencing such changes eventually have difficulty performing activities of daily living, have increased risk of falls and fractures, and are easily fatigued, which may in turn lead to disability and loss of independence.[3] Many factors—the aging process, chronic illness, inadequate nutrition, and sedentary lifestyle—contribute to muscle weakening. But exercise and nutrition are the mainstays of treatment.[4] This presentation reviews benefits of increasing physical activity in older people, and it also reviews the various types of training used to achieve these benefits.

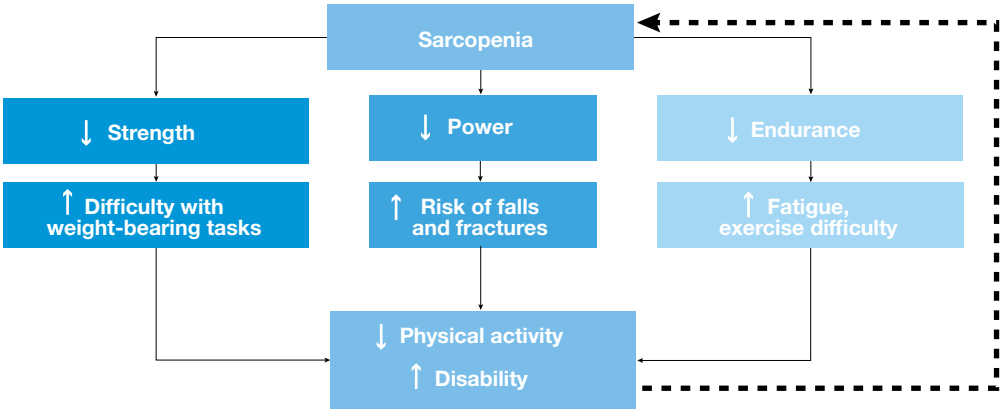

Figure 1. Sarcopenia in older people: characteristics and functional consequences

In the young and old alike, physical activity requires power, strength, and endurance. Power is the ability to generate high force as fast as possible, as needed for a vertical jump. Strength, on the other hand, is the ability to generate as much force as possible with no concern for the factor of time, such as lifting a heavy object. Endurance is the stamina or energy to sustain a physical activity. Power building uses resistance training with rapid repetitions over brief intervals. Strength building similarly uses resistance, but exercises are performed more slowly. Endurance training usually involves aerobic exercise, such as walking or running, to develop energy production systems that meet the demands of physical activity.

The nature of the muscle deficit in age-related sarcopenia is not yet understood. Recent reports suggest that older individuals may have lower sensitivity and responsiveness to anabolic signals that regulate muscle protein synthesis.[5-7] Decreased intramuscular expression of mTOR, lower levels of specific signal kinases, and lowered activity of factors that initiate protein translation may underlie the decrements in muscle synthesis in the elderly. In addition, gene expression of proteolytic regulators appear to be higher in old compared to young muscle, both at rest and following exercise.[8]

Despite potential limits to muscle maintenance in the elderly, various exercise regimens have proven effective for preventing or reversing aspects of sarcopenia—with results such as enhanced muscle hypertrophy, increased muscle strength and power, and improved measures of functional capacity. Progressive resistance training has been shown to significantly improve muscle strength, gait velocity, and stair-climbing in older people.[9] Other studies provide support for the use of power training and endurance training in the elderly. For obese older adults, the optimal strategy for reducing both functional limitations and insulin resistance was a combination of resistance and aerobic exercise.[10] A study in functionally limited elders (mean age, 74.2 years) showed that high-velocity, high-power training improved lower extremity muscle power and muscle quality to a greater extent than did traditional slow-velocity resistance training.[11] Likewise, Nogueira et al conducted a head-to-head comparison of high-velocity power training with low-velocity strength training in older men (69-76 yrs), which showed that power training yielded better results in muscle hypertrophy.[6]

Based on recent data regarding exercise benefits for older people, the following training strategy is suggested to sustain muscle maintenance and accretion, with the aim of supporting and improving functional capacity in older people.

- Initiate training with low-velocity strength/resistance exercises twice weekly on nonconsecutive days for 3 to 4 weeks; start at 50 percent of one repetition maximum (RM) and progress up to 80 percent RM with 10-15 repetitions. Begin with 1 set, then progress toward 3 sets with 1-3 minute rest periods between sets. Move from large to small muscle groups or from upper to lower muscle groups.
- Progress to high-velocity power/resistance training twice-weekly on nonconsecutive days.
- Supplement strength or power training with endurance training on days when strength or power training is not done.

In conclusion, it is important to recognize that age-related sarcopenia can be prevented, delayed, or partly reversed by use of training regimens designed to improve strength, power, and endurance. Widespread implementation of community-based programs can have a positive impact on public health.[12]

Take-home messages

- Reducing sedentary behavior and increasing physical activity should be a priority worldwide.
- Measures of age-related sarcopenia can be offset, delayed, or partly reversed by use of training regimens designed to improve strength, power, and endurance.
- Training programs for older people begin with mild exercise and progress stepwise to more intense activities.

References

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Discussion

José Antonio Serra: In order to avoid complications, what kind of health assessment do you recommend prior to starting an exercise program?

Jeffrey Stout: Actually, quite a number of tests. It is important to consult with the trainee's primary care physician. Also, I recommend a cardiovascular stress test under supervision of a physician. For exercising, I recommend working with a trainer, and progressing slowly.

Keith Wheeler: How do you deal with the believability factor? What is your assessment of the motivation of people you've worked with to continue exercising on their own?

Jeffrey Stout: That's a good question. With training, the motivation to continue comes from the life-changing effects of exercise. People are aware of their increase in strength, power, and independence. They notice it at home, in the course of daily activities. One lady cried when our study ended. Study subjects often ask how to continue workouts on their own. I refer them to their physicians, and I have since seen some of them working out at our University facilities.

We [younger adults] sometimes take physical activity for granted—getting up out of a chair, performing daily activities of life. For older people, these are big issues. It's very rewarding to see them experience the benefits of exercise.

Cecilia Hofmann: What are the comparative risks of resistance training versus endurance training, related to cardiac function especially?

Jeffrey Stout: That's a very good question. I'm a resistance trainer guy; but endurance training is also very important. When you look at functional outcomes, resistance training is a little bit better. And endurance training has higher risk for cardiology issues. If you look at the literature on heart attacks and activity, what exercise were they doing? It's always endurance.

Juergen Bauer: There has been some concern in the community about starting power training, that is, concern about getting mechanical lesions in the tendons, or muscle ruptures. Do you have any experience with that?

Jeffrey Stout: Those are risks of training that start with high-velocity power exercises right away. Inflammation is another safety concern. If you build strength first, then move to the high-velocity training, no study has reported any major adverse events.

Jean-Pierre Michel: You stressed the importance of resistance exercises to stimulate myocyte cells. Can we stimulate them in other ways, for example with drugs or another kind of exercise, or something else?

Jeffrey Stout: In the future, we will likely use drugs and nutrition.

Jean-Pierre Michel: Can we use Tai Chi or something like that now?

Jeffrey Stout: Oh yes, Tai Chi and yoga. The mechanical action of stretching muscle actually stimulates cellular protein synthesis and activity of satellite cells. Any type of exercise works, depending how out of shape the patients are. Yoga and Tai Chi are very good methods, and they seem to be safe. Any physical activity is beneficial. Under research conditions, we are trying to maximize strength and power and muscle hypertrophy, so we always go with resistance exercise. But other activities are also good: swimming, cycling, anything to get active. We'll worry about exercise progression after that.

Fatih Tufan: You suggested exercise frequency of 2 times per week. Is a more frequent exercise program harder to achieve or harmful?

Jeffrey Stout: I prefer twice a week unless different muscle groups are being exercised in different sessions. Especially with older folks, we have to allow ample time for repair and recovery. Timing depends on the workout intensity, but I think it is very important to have 2 days between sessions.