CLINICAL PRACTICE

Update

Sarcopenia

Exercise as a treatment strategy

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BACKGROUND

Sarcopenia, the age related decline in muscle mass, is associated with a reduction in muscle function, physical performance, quality of life, and loss of independence. Exercise, specifically resistance (weight) training, has been shown to be an effective countermeasure, arresting decline and substantially improving physical function.

OBJECTIVE

This article reviews the prevalence of sarcopenia, underlying processes, and the role of exercise as a treatment strategy. Practical guidelines are provided for prescribing exercise to older patients.

DISCUSSION

The aging neuromuscular system is highly responsive to resistance training. Resistance can be applied using specialised weight training machines, elastic bands, objects around the home, or body weight. Training once or twice a week targeting the major muscle groups at moderate intensity is sufficient for improvement.

Aging is characterised by a gradual decrease in muscle mass and muscle strength which contributes to a decline in physical function, increased disability, frailty, and loss of independence. Age related loss of muscle mass – which is largely responsible for the decline in muscle strength – is referred to as 'sarcopenia' (Greek: *sarx*-flesh, *penia*-loss)[1] (*Figure 1*).

Apart from the impact on the individual's quality of life and independence, the economic burden of sarcopenia is significant[2] and reported to be comparable to that attributable to osteoporosis.[3] With older adults projected to comprise approximately 20% of the Australian population by 2021 and more than 25% by 2051,[4] the health care costs associated with sarcopenia will escalate.

Assessment and prevalence

Several indexes and measurement techniques have been used to categorise sarcopenia. A common parameter is the relative skeletal muscle index (RSMI) (defined as appendicular skeletal muscle/height in metres, squared) more than two standard deviations below the sex specific mean for young healthy adults.[5] Appendicular skeletal muscle is generally derived from dual energy X-ray absorptiometry (DEXA) scanning, although an anthropometric equation can also be used.[5] A RSMI less than 5.45 kg/m2 and 7.26 kg/m2 are classed as sarcopenia in women and men, respectively. In addition, fat free mass,[6] muscle strength,[7] and loss of hand grip strength[8] have been used to define sarcopenia. In the clinical setting, a low body mass index may be a useful predictor of sarcopenia.[9]

The prevalence of sarcopenia increases with age with those aged over 80 years most affected (*Table 1*). Considerable variation exists among studies with average rates of approximately 20% in those aged 60 years and over.[5,6,9–13] However, these studies are likely to underestimate the true prevalence as participation by the frail and institutionalised elderly is limited.[10] It should also be noted that these studies have been conducted predominantly in caucasians in the USA and variations in prevalence by race and ethnicity may exist. In addition, sarcopenia and obesity may coexist (sarcopenic obesity) and these individuals may be at greatest risk for morbidity and disability.[14,15] This condition may be difficult to recognise in the clinical setting as body size and fat mass mask the deficiency in muscle mass.

Factors underlying sarcopenia

A number of factors have been implicated in the pathogenesis of sarcopenia including age related loss of muscle fibre, reduced physical activity, hormonal decline (both reproductive and the hypothalamic-GH-insulin-like growth factor-I axis), nutritional insufficiency (caloric

intake and protein), and low grade systemic inflammation.[16] Recently, a genetic component has been identified with an association between the vitamin D receptor genotype and sarcopenia.[17] However, the magnitude and interplay of these pathophysiological processes is yet to be clarified.

Two factors are readily modifiable: physical activity and diet. Pharmacological intervention is also possible, such as growth hormone and testosterone supplementation, however gains derived from treatment are less than that with exercise, are costly, and associated with adverse side effects.[18]

Role of exercise

Numerous studies conducted since the late 1980s have demonstrated that resistance or weight training is an effective countermeasure to sarcopenia. Frontera et al[19] reported increased muscle cross sectional area (CSA) of the mid-thigh (11.4%) and muscle strength (>100%) following 12 weeks of high intensity training in older men. Substantial changes were subsequently observed in community dwelling older women following resistance exercise.[20] Even in frail nursing home residents, impressive improvements in muscle CSA (3–9%), strength (>100%), and functional performance such as gait speed and stair climbing ability, have been observed following progressive resistance training.[21,22] Consequently, age is no barrier to the enhancement of muscle mass and function following resistance exercise, with improvements comparable to that observed in younger adults (they may be greater due to older adults' deconditioned state). Moreover, these programs are relatively safe, even in those with comorbidities, and can aid in the prevention of falls,[23] disability, and loss of independence.[24,25] Gains of 5–10% in muscle CSA, accompanied by increases of 20–100% or more in muscle strength depending on muscle group, would be reasonable expectations from an appropriate exercise regimen.[26] In contrast to resistance exercise, aerobic activity such as walking, cycling or jogging has a negligible effect on augmenting muscle mass and strength.[27–29] In addition, resistance exercise has been associated with improvements in a number of clinical conditions in older adults including osteoarthritis,[30] osteoporosis,[31] coronary heart disease,[32] diabetes,[33] and depression.[34]

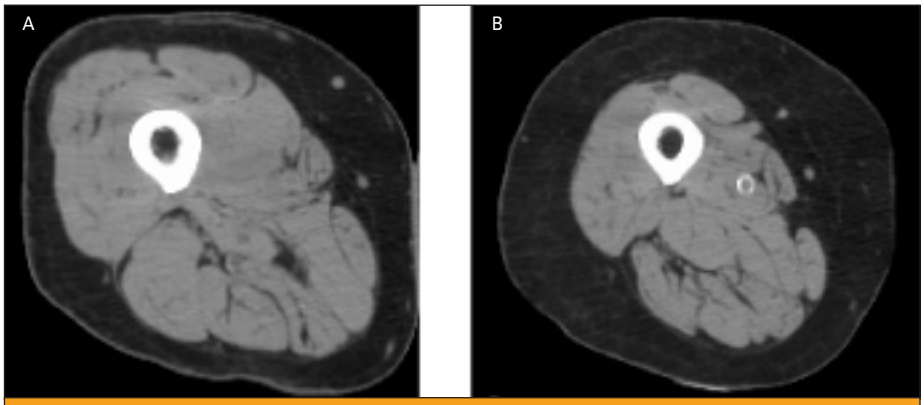

Figure 1. Mid-thigh CT scans of a 72 year old woman: A) without sarcopenia, and B) with sarcopenia. Both women are community dwelling, with a body mass index of 25 kg/m2

Guidelines for exercise prescription

In designing a resistance exercise prescription, the components manipulated are the number of sets and repetitions, repetition velocity, rest intervals, intensity, frequency, and duration (*Table 2*). The goal is to progressively overload the muscles so that positive adaptations take place, ie. an increase in muscle size and muscle function (strength, power, and endurance). Exercises should be dynamic not static, and should target the major muscle groups of the body using both concentric (lifting or pushing) and eccentric (smooth and controlled lowering) movements. Lower extremity muscle groups – such as the knee and hip extensors, knee flexors, dorsiflexors and plantarflexors – should be prioritised as they are critical for mobility, balance, and the prevention of falls. Exercise machines that use weight stacks or hydraulics (where resistance is adjusted by pins or a dial) are effective in isolating the target muscle groups, safe in that the weights can't be dropped, and the movements and adjustments required can be easily and quickly learned. Free weights (dumbbells and barbells) can also be used although, for some exercises such as a bench press (where the weight is raised above the chest when in a supine position) a spotter is required and the activity is more technically challenging than with a specialised exercise machine. Ankle and wrist weights, body weights, and household objects such as milk containers filled with pebbles or sand are inexpensive and can also be effectively used for resistance. Elastic bands, such as those available in sports stores, provide different levels of resistance and replicate many of the activities performed with resistance exercise machines. A partner may also apply resistance during movements such as knee and elbow extension and flexion. Gains in muscle strength can be substantial in the first several weeks with a plateau often reached by 5–6 months. These gains in strength reflect both neural and muscular adaptation, with muscle fibre hypertrophy becoming dominant with extended training duration.[35] Some minor soreness generally occurs after the first few sessions (or when new exercises are included) but should quickly resolve.

The resistance exercise program

It may be more efficient and practical to refer the patient to an Australian Association for Exercise and Sports Science (AAESS) accredited exercise physiologist (www.racgp.org.au/folder.asp?id=1057) or to a reputable local health and fitness centre that has trained staff. Contraindications and exercise concerns as well as muscle groups that require special attention should be listed on the referral. However, referring the patient may not always be possible or appropriate, especially in the rural setting. In addition, factors such as cost and transportation may be barriers to participation. Consequently, two options remain: provide a home based program or – if patient numbers are sufficient – develop a small scale exercise facility in a medical clinic. Program recommendations can be found in *Table 3* and specific exercises for the respective muscle groups can be found at www.myfit.ca/exercisedatabase/exercise.asp which includes illustrations and descriptions of the movements. Minimal equipment is required to set up an exercise room, which could comprise

of only a multi-station exercise machine, some hand held weights, and elastic bands. For a home based program, activities using body weight and household items can be used as the resistance for many of the exercises illustrated in the above website. For instance, repeated chair rises and stair climbs can be used to enhance the knee extensors, repeated rising up on the toes can be used to exercise the dorsiflexors, and hand held objects can be used to provide resistance for the elbow flexors and extensors. In addition, elastic band exercises can be used. Information and illustrations regarding their use can be found at www.FirstStepToActiveHealth.com.

Table 1. Increased prevalence of sarcopenia with age[4]

Age	Women	Men
<70	23.1%	13.5%
70–74	33.3%	19.8%
75–80	35.9%	26.7%
>80	43.2%	52.6%

Monitoring the patient's progress (including adverse events) and providing encouragement will aid in exercise adherence.

Conclusion

As all older adults are subject to loss of muscle mass and strength, some form of resistance exercise should be incorporated into their weekly schedule and maintained on an ongoing basis, thereby enhancing/maintaining their reserve capacity and reducing the likelihood of falling below thresholds for disability. Ideally this would be one component of an activity program that includes cardiovascular exercise, flexibility, and balance training. The FistStepToActiveHealth website contains information for a comprehensive physical activity program, providing resources for both the physician and patient.

Summary of important points

- Sarcopenia is largely responsible for the loss of muscle strength, and contributes to a decline in physical function, disability, loss of independence, morbidity and mortality.
- Biological and lifestyle factors underlie this condition, with reduced physical activity readily modifiable.
- Resistance exercise is a simple, inexpensive, readily accessible, and effective countermeasure.
- Once or twice weekly training of the major muscle groups at a moderate intensity is sufficient for improvement.

Table 2. Components of a dynamic resistance exercise prescription

Repetition	One complete movement of an exercise
Set	Series of repetitions performed without stopping (eg. 8 repetitions/set)
Intensity	Amount of weight lifted and can be determined by the percentage of one repetition maximum (1-RM) or a specific number of repetitions maximum (RM)
RM	The maximal number of repetitions that can be performed at a given exercise intensity (eg. 8 RM)
1-RM	The maximal weight that can be lifted once with acceptable form
Velocity	Repetition movement speed (eg. 2–3 seconds concentric and 2–3 seconds eccentric)
Frequency	Days per week
Duration	Length of an individual session (eg. 40 minutes)

Table 3. Resistance training program recommendations

Exercises	8–10 that target the major muscle groups
Repetitions	8–12 per set. When able to achieve 12 repetitions, increase resistance so that 8 repetitions are possible
Sets	Minimum of 1, preferably 2–3 per exercise with 1–2 minutes rest between sets
Frequency	1–3 days per week with at least 48 hours between sessions
Velocity	2–3 seconds concentric and 2–3 seconds eccentric. Some sets of rapid concentric movements can also be included
Breathing	Normal breathing on each repetition (no breath holding)
Duration	Less than 1 hour

Conflict of interest: none declared.

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