



Role of exercise on sarcopenia in the elderly

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Sarcopenia leads to a loss of strength, later on to a decreased functional status, impaired mobility, a higher risk of falls, and eventually an increased risk of mortality. There are many factors responsible for the decline of muscle mass and muscle strength associated with aging, although the complex, multi-factorial mechanisms driving the sarcopenic process are not clearly understood. Physical inactivity or a decreased physical activity level is a part of the underlying mechanisms of sarcopenia and therefore physical activity can be seen as an important factor to reverse or modify the development of this condition. Several treatments have been proposed for the treatment of this loss of muscle and strength, but there is no doubt that exercise represents the most important approach to prevent and treat sarcopenia. In this review, we describe first the conceptual distinctions between the terms sedentary behaviour, physical activity and exercise. In addition, we review the benefits of physical activity in the elderly population, including lower mortality and functional independence, and discuss the four categories for specific recommendations for exercises (aerobic exercise, progressive resistance exercise, flexibility and balance). Finally we discuss the principles governing the prescription of physical activity for older people with sarcopenia and make some specific advices for how to engage older adults in appropriate exercise.

KEY WORDS: Sarcopenia - Exercise - Motor activity - Postural balance - Lifestyle.

"Lack of activity destroys the good condition of every human being while movement and methodical physical exercise save it and preserve it".

Plato

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Sarcopenia, initially defined as an age-related loss of muscle mass,¹ is now considered a syndrome characterized by progressive and generalized loss of skeletal muscle mass and strength associated with ageing.² It is a complex medical condition that predicts mobility, disability, leading in turn to loss of independence, a higher risk of falls, reduced quality of life, increased health care costs and eventually an increased risk of mortality.³

Even in healthy persons, muscle mass declines at approximately 1% per year from the peak between 20 and 30 years old, and accelerates from 50 years, particularly in the lower extremities.

This decline occurs gradually in men, whereas it occurs sharply in women after menopause.^{4, 5} There are many factors responsible for this decline of muscle mass and muscle strength associated with aging. It seems that the anabolic potential of skeletal muscle may be reduced in the elderly. Insulin resistance, inflammation, hormonal alterations, perturbations in muscle metabolism and decreased muscle proliferation are the main changes involved. In addition to the aging process, there have been identified several risk factors that favor its appearance, most notably sedentary lifestyle, female gender and some organ diseases.^{3, 6} Overall, the most prominent cause of sarcopenia is inactivity. Although it does not com-

pletely revert with exercise, the absence of physical activity (PA) accelerates muscle mass loss.

Different strategies have been tested for its treatment: human growth hormone, androgens, estrogens in women, nutritional treatment and exercise. Of all the therapeutics available, PA with or without dietary supplementation has shown its efficacy in increasing skeletal muscle mass.

Before we provide in this review more information detailing the role of exercise in sarcopenia, we will briefly offer some definitions of terms in order to avoid misunderstandings, errors and inconsistencies using this terminology. Casperson *et al.* attempted 27 years ago to provide a common framework for researches from different fields to communicate.⁷

Physical activity (PA) is any bodily movement produced by contraction of skeletal muscle that substantially increases energy expenditure, although the intensity and duration can vary substantially.⁸ Baseline activity is, however, the smallest increments of body movements produced by skeletal muscle contractions that increases energy above sedentary behaviors (*e.g.*, standing, slow walking, lifting very light objects, etc.).⁹ Consistent with this definition, individuals who do only baseline activity are not sedentary, *per se*, but are still considered to be inactive. PA may be measured in terms of METs (metabolic equivalents), units used to estimate the metabolic cost (oxygen consumption) of PA. One MET equals the resting metabolic rate of approximately 3.5 mL O₂/kg/min, and represents the approximate rate of oxygen consumption of a seated adult at rest. Moderate physical activity includes activity performed at an intensity of 3 to 6 METs (leisure cycling, moderate effort swimming, playing golf walking, general cleaning at home, or lawn mowing), or the equivalent of walking briskly at approximately 5 to 8 kilometers (3 to 5 miles) per hour.¹⁰ Vigorous physical activity includes activity performed at >6 METs, such as running, rope jumping, and calisthenics (*e.g.*, push-ups, pull-ups, sit-ups, jumping jacks).

Exercise is a subcategory of leisure time PA in which planned, structured, and repetitive bodily movements are performed to improve or maintain one or more components of physical fitness. Participation in exercise and the accumulation of PA have been shown to result in improvements in physical fitness that is a set of attributes that contribute to the ability to perform physical work: cardiorespiratory endurance, skeletal muscular endurance, skeletal

muscular strength, skeletal muscular power, speed, flexibility, agility, balance, reaction time, and body composition.¹⁰

Sedentary behaviors (SB) are defined as a way of living or lifestyle that requires minimal PA and that encourages inactivity through limited choices, disincentives, and/or structural or financial barriers.⁸ They include the time spent sitting or lying which has been shown to be a modifiable risk factor of cardiovascular disease, type 2 diabetes mellitus, obesity, some cancers, skeletal health. Moreover they have a negative impact on some aspects of mental health, overall mortality, disablement and frailty as well as poor quality of life, independently from physical activity levels.¹¹ Besides that, SB affects muscle physiology, lead to weakness and accelerates sarcopenia. But it would be feasible that these age related declines in muscle mass and function were also the principal drivers of increased SB among aging persons.^{12, 13}

Finally, lifestyle modification refers to the use of opportunities in a person's daily routine to increase energy expenditure (*e.g.*, manually open doors, carry groceries, use stairs rather than elevators, parking further from entrances) and substitute active for sedentary leisure time.¹⁴

The purpose of this review is to examine whether the different types of exercise show to be beneficial for treatment and prevention of sarcopenia among older adults.

Mechanisms of sarcopenia

Muscle mass is the primary determinant of strength. Males are generally stronger than females primarily because they have larger muscle mass. The loss of muscle mass during the ageing process is clinically important as it leads to reduced strength and exercise capacity, both of which are required undertaking normal daily living activities. Although we will all lose muscle mass as we age, individual differences in the rate of loss in muscle mass, the age at which muscle mass starts to decline, and the individual's peak muscle mass, determine the impact that sarcopenia has on functional ability.¹⁵

Several physiological mechanisms are involved in the cause of the syndrome including changes affecting neuromuscular transmission, muscle and tendon architecture, fiber composition, excitation-contrac-

The influence of PA in sarcopenic muscle can be

However, these factors are not common to all elderly and/or sarcopenic individuals. Within clinical study cohorts, a large degree of heterogeneity exists that complicates the work of clinical and translational scientists studying sarcopenia. Furthermore, variability in lifestyle and disease conditions induces different atrophy-related mechanisms and degrees of atrophy. Therefore, global therapeutic approaches are unlikely to prove equally effective in all models of sarcopenia.

It is never too late to become physically active. For older adults, the benefits of PA, including lower mortality and functional independence, occur with initiation and maintenance of exercise. Even individuals who were previously sedentary but initiate exercise as late as age 85 demonstrate a significant

Increasing PA in old age improves quality of life, psychological health and is associated with better mental health and social integration, improves anxiety, depression and self efficacy for PA in older adults.³⁵ The relationship between neurological disorders and sarcopenia are discussed in detail in another review in this issue.

As reviewed in several epidemiological studies ⁴⁵⁻⁴⁷ regular practice PAS exercise is associated with decreased risk for activities of daily living disabil-

Types of exercise

Aerobic exercise (AE)

Although advancing age is accompanied by an accelerating reduction of AE capacity, that is exacerbated by many comorbidities common to the elderly, it has long been linked to improvements in cardiovascular fitness and endurance capacity in older adults, both in healthy and diseased individuals. Notwithstanding that AE is believed to largely decrease most of risk factors for cardiometabolic diseases and attenuates chronic inflammation, with minimal effects on muscle mass and strength, it can increase the cross-sectional area of muscle fibers.⁵⁰ AE can also reduce body fat including intramuscular fat which in turn improves the functional role of muscle relative to body weight.^{51, 52}

It is a form of structured PA that is generally defined as exercise that requires muscles to generate force to move or resist weight, with the intensity increasing as physical capacity improves. Structured PRE relies on anaerobic metabolism to meet energy demands and examples of PRE activities include lifting weights, working with resistance bands, doing calisthenics using body weight for resistance (such as push-ups, pull-ups, and sit-ups), climbing stairs, carrying heavy loads, and heavy gardening.⁴⁹

Several investigations have reported that after even short durations of PRE, protein synthesis rate and neuromuscular adaptive-responses among elderly adults were similar to that of young subjects, despite a much lower pre-exercise rate.⁵⁴⁻⁵⁶

PRE attenuates development of sarcopenia by many ways: improving muscle size and function, reducing balance and flexibility problems and reducing also the risk of development of many sarcopenia-related comorbidities.⁶⁰

The effectiveness and outcomes of this type of exercise depends on some factors as intensity, training volume (sets by repetitions), frequency and type of recommended exercises (isokinetic/variable resistance/isoinertial), periods of recovery between sets and frequency training.⁶² Different combination of these variables (number of repetitions per set, number of sets and rest between sets) originate different physiological responses. Thus in general, all training programs induce certain improvements on

strength, hypertrophy or muscle power. However, certain combinations will have a particular emphasis on one of these manifestations.

Volume of PRE measures the total amount of exercise made and it is expressed in terms of the number of repetitions, total kilograms raised, duration of the session or period training. The best definition is the total number of sets performed per unit of time. A widely accepted definition for this is volume load (VL), which takes into account the total number of performed sets, repetitions and weight (kg) lifted (*i.e.*, (total repetitions [no.] x external load [kg]); however, since most published PRE studies for older adults do not include VL as a prescription entity, it is difficult to draw conclusions regarding the dose-response relationship.

Frequency is defined as the occurrence, per unit of time (*e.g.*, calendar week) that a full-body PRE regimen is completed. Training frequency recommended is 3-5 days per week. Train less than two days a week does not produce a significant increase in the maximal oxygen consumption. Moreover, the benefit additional health training obtained above five days a week is minimum, and the incidence of injury can increase.

Intensity is commonly defined as the percentage of maximal ability for a given exercise (*i.e.*, one-repetition maximum [1RM]). Although this operational definition for intensity provides a more objective, quantifiable unit than training fatigue or rating of perceived exertion, current recommendations for older adults still rely on a 0-to-10 RPE (perceived physical exertion) for moderate-intensity (5 to 6 out of 10) and vigorous-intensity (7 to 8 out of 10) PRE.^{8, 40} Alternatively, intensity of PRE may be modified based on a targeted number of repetitions, or by increasing loading within a prescribed repetition-maximum range (*e.g.*, 8-12 RM).⁶¹

Emphasis on muscle power (how fast the muscle contracts) rather than strength alone may help patients retain the greatest amount of functional capacity as they age. Regardless of age or health status, continual improvement requires a progressively increasing resistance as the patient becomes stronger. But current recommendations for older adults do not reflect the viability of progression in PRE dosage to accommodate a hierarchical muscular adaptive-response to training, in spite of a significant body of literature to support its safety and effectiveness.⁶³

Besides that, recent evidence from two meta-anal-

yses^{21, 64} has revealed that PRE is effective for eliciting significant strength adaptation and increases in lean body mass among older adults, and that there is a robust dose-response relationship such that volume and intensity are strongly associated with adaptations.

However, it seems evident that the realization of repetitions to failure with these excessive intensities may pose an unnecessary effort, besides being detrimental for health and performance, not only for these special population groups (*e.g.*, aging, obesity, diabetes) but also for most athletes. Furthermore, there is little evidence that shows the superior effect of these intensities over other more lower (*e.g.*, 20RM-30RM) in previously untrained people.⁶⁵ A recent review, which analyzes which training intensities are correlated to strength increase in the elderly,⁶⁶ concludes that intensities are higher than the low improvement in terms of maximum force but not necessarily in terms of functional gains.

Flexibility exercises

It is the ability to move a joint through a complete range of motion. This limited range of motion in the hip, knee, and ankle joints may increase the risk of falls and contribute to age-related gait changes. Although there is scant research devoted to examining the impact of flexibility on health outcomes, it is considered paramount to overall good physical health. Stretches can be static (assume position, hold stretch, then relax); dynamic (fluid motion [*e.g.*, Tai-Chi]); active (balance while holding stretch, then moving [*e.g.*, yoga]); or a combination (proprioceptive neuromuscular facilitation).⁴⁹

Balance training

Postural hypotension, impaired proprioception, vision, larger postural sway, slower gait velocity and slower correcting reflexes are the major factors that occur with age. Balance is the exercise that helps maintaining stability during daily activities and other exercises, preventing falls. It can be static (*e.g.*, stand on one leg) or dynamic (*e.g.*, walk a tightrope), with hand support as needed. Examples of balance training include tandem walking, standing on heels or toes, walking on compliant surface such as foam mattresses, maintaining balance on moving vehicles such as bus or train, walking backward.⁴⁹

Exercise interventions and sarcopenia

Although there is currently no consensus recommendation for PA and exercise among older adults with sarcopenia, there are some recommendations for adults over the age 65 years for various types of activity and specific guides for implementing such programs. We will provide in the following section an overview of current and specific recommendations, for PA in the elderly, many of which have been proven to be useful in preventing or attenuating sarcopenia.^{8, 25, 40, 49, 67}

General recommendations

Older adults are a varied group. Most, but not all, have one or more chronic conditions that vary in type and severity. All have experienced a loss of physical fitness with age, some more than others. This diversity means that some older adults can run several miles, while others struggle to walk several blocks. Starting an exercise program later in life can significantly reduce risk factors even if a person was sedentary when he or she was younger, so we should avoid ageism when we are prescribing exercise. Several areas should be emphasized in promoting PA in older adults:^{8, 25, 26, 40}

- Before arranging for an exercise program, physicians should consider and identify specific activities that a patient prefers, according to their social preferences, cultural norms, exercise history, readiness, motivation, self-discipline and short and long term goals and logistics.

- An activity plan is recommended for all older adults. This plan should be individualized with specific objectives and tasks and tailored according to chronic conditions and activity limitations, risk for falls, individual abilities and fitness.

- The PA prescription should be done in the same manner as clinicians prescribe drugs for a disease. The plan has to define what, how, when, where, and how often each activity will be done. For example “Take a 10-minute walk, three times a day, every day of the week. Choose a speed that allows you to talk but that is moderately hard work. The distance is not important, but make sure to walk for the entire 10 minutes”.

- The progression of activities (duration and intensity) should also be individual: a conservative approach may be necessary for the most deconditioned

and physically limited older adults to minimize the risk of injury. Many months of activity at less than recommended levels is appropriate for very deconditioned older adults as they increase activity in a stepwise manner. In addition, activity plans need to be re-evaluated when there are changes in health status.

- Muscle strengthening activities and/or balance training may need to precede aerobic training activities among very frail individuals.

- Proper warm-up and stretching are particularly important with careful instruction on balance and breathing. A warm-up with aerobic activity usually consists of short intervals of low-intensity movement (e.g., walking for 5 minutes).

- Sensory impairments, such as hearing loss, can make it difficult to instruct older adults. Therefore, speaking loudly and slowly, using visual aids, and demonstrating exercises are all techniques that help older adults become active.

- Supervision, monitoring, teaching, and encouragement are essential, recognizing that long adaptation periods may be needed as deconditioned elderly may develop aches and pains as they begin a more active lifestyle. Supervision is best when it comes from people familiar with the special needs of the elderly.

- Finally, in the absence of contraindications, protein intake should be about 1.5 g/kg per day to elicit a robust acute muscle protein synthetic response above that seen at rest. Evidence suggests that the elderly may need to distribute this protein intake evenly throughout the day. Studies combining protein supplements with exercise have obtained the best outcomes when supplementation is administered immediately after exercise. The use of protein supplements without exercise, however, has not had any effect on muscle mass.⁶⁸

Lifestyle modifications

Prescriptions should encourage patients to limit sedentary activities such as television watching and computer use, as recent studies also show that breaking up sedentary time can be beneficial. This can include behaviors that result in a transition from sitting to a standing position or from standing still to beginning to walk. Useful goals include structuring activity into a normal daily routine, as self transportation (walking, bicycling), take stairs instead eleva-

Specific recommendations for exercise

The exercise prescription for elderly patients does not differ significantly from the prescription for younger adults. It is recommended that adults participate in a minimum of 150 minutes of moderate intensity or 60 minutes of vigorous PA per week. Older adults with functionally limiting chronic diseases should be as active as their medical conditions allows in order to reduce sedentary behavior.⁴⁰

AEROBIC EXERCISE

Moderate-intensity aerobic activity involves a moderate level of effort relative to an individual's aerobic fitness. On a 10-point scale, where sitting is 0 and all-out effort is 10, moderate-intensity activity is a 5 or 6 and produces noticeable increases in heart rate and breathing. On the same scale, vigorous-intensity activity is a 7 or 8 and produces large increases in heart rate and breathing. For example, given the heterogeneity of fitness levels in older adults, for some older adults a moderate-intensity walk is a slow walk, and for others it is a brisk walk.⁴⁹

However, the guidelines emphasize that for most health outcomes, additional benefits occur as the amount of PA increases through higher intensity, greater frequency, and/or longer duration. The guidelines stress that if older adults cannot do 150 min of moderate-intensity aerobic activity per week because of chronic conditions, they should be as physically active as their abilities and conditions allow.⁴⁹

On the other hand, the minimal 150 minutes of moderate-intensity PA per week may be insufficient for weight loss for overweight or obese individuals. Older adults who are overweight may need the equivalent of 300 minutes per week of moderate-intensity PA to adequately manage weight control, in conjunction with an appropriate diet.⁸

This recommended amount of aerobic activity is in addition to routine activities of daily living of light-intensity (*e.g.*, self care, cooking, casual walking or shopping) or moderate-intensity activities lasting less than 10 min in duration (*e.g.*, walking around home or office, walking from the parking lot).⁴⁰

Because an optimal effect on the mechanical and metabolic properties of aged muscle cannot be obtained by a single type of exercise, and considering that AE is better than PRE for developing endurance capacity, it has been suggested that these types of exercises should be combined to combat the global issues of sarcopenia in the elderly population.^{69, 70} As an original aerobic training program for sedentary aged people, aerobic interval training (AIT; weekly exercise sessions with 4-minute repetitions at a moderate aerobic intensity alternated with one-minute repetitions at a sub-high aerobic intensity) could next be considered in sarcopenia. AIT improves aerobic capacity and maximal aerobic power in sedentary aged subjects, while a sub-high aerobic

intensity repetitions program tends to increase the metabolic stimulus to resistance exercise in an aerobic training program.⁷¹

Progressive resistance exercise (PRE)

The current guidelines also call for PRE to be performed two or more nonconsecutive days per week, using a single set of 8-10 exercises for the whole body, and at a moderate (5-6 RPE out of 10) to vigorous (7-8 RPE out of 10) level of effort that allows 8-12 repetitions.^{8, 40}

The type of recommended exercise are muscle strengthening activities that involve all the major muscle groups (legs, hips, chest, back, abdomen, shoulders and arms), with a progressive weight training program, stair climbing, and other strengthening activities that use the major muscle groups, or weight bearing calisthenics (8-10 exercise involving the major muscle groups of 8-12 repetitions each). Do not forget about providing a 2 minutes of rest between exercises. Some PRE training examples alternating between upper and lower body work, should be the following:

- upper body: chest press, shoulder press, triceps extension, biceps curl, lateral pull-down (upper back);
- midsection of the body: lower-back extension, abdominal crunch/curl-up;
- lower body: quadriceps extension or leg press, leg curls (hamstrings), calf raise.

Due to the disproportionate degree of muscle atrophy and strength decline of the lower limb musculature during aging,⁴ a PRE intervention model for positive effects on lower-extremity strength is recommended to provide enhancement of overall functional capacity.

The technique of this PRE prescription refers to perform each exercise through a full range of motion, in a controlled rhythmic manner, and at a slow to moderate speed, avoiding breath-holding and straining (Valsalva manoeuvre) and emphasizing proper body mechanics throughout each exercise. They should be repeated until the point at which it would be difficult to do another repetition without help.

Following a familiarization period, in which very low dosage training takes place 1-2 times per week it may be expected that older adults with sarcopenia can benefit from gradual increases in training dos-

age to accommodate improvements in strength and muscle hypertrophy. Varying the type of exercises, increasing the level of resistance; increasing by 5% up to 40% of 1 RM for arm exercises and up to 60% of 1 RM for leg exercises, adding a second set of exercises without increasing level of resistance and adding a third day of resistance training during the week are some suggestions to pertain to progression in PRE.⁶²

Flexibility

There are a small number of studies that have documented the effects of flexibility exercises in older populations. There is some evidence that flexibility can be increased in the major joints by these exercises; however, how much and what types of flexibility exercises are most effective have not been completely established.⁴⁰ The ACSM recommendations states that flexibility exercise should be done at least two days per week, ten minutes per day at a moderate intensity (5-6) on a scale of 0 to 10 and including exercise for the neck, shoulder, elbow, wrist, hip, knee and ankle.⁴⁰ Preferably, flexibility activities are performed on all days that aerobic or muscle-strengthening activity is performed.

Balance

There are no specific recommendations regarding specific frequency, intensity, or type of balance exercises for older adults. Preferably, older adults at risk of falls should do balance training three or more days a week. The exercises can increase in difficulty by progressing from holding onto a stable support (like furniture) while doing the exercises to doing them without support. Participation in Tai-Chi classes also improves balance and reduces the risk of falls.

The ACSM guidelines recommend activities that include the following:⁴⁰ progressively difficult postures that gradually reduce the base of support (*e.g.*, two-legged stand, semitandem stand, tandem stand, one-legged stand); dynamic movements that perturb the centre of gravity (*e.g.*, tandem walk, backward walking, sideways walking, heel walking, toe walking circle turns, standing from a sitting position, walking on compliant surface such as foam mattresses, maintaining balance on moving vehicles such as bus or train); stressing postural muscle groups (*e.g.*,

heel stands, toe stands) and reducing sensory input (e.g., standing with eyes closed).

Exercise precautions

Common problems with exercise in the elderly are those related to comorbidity, which is a very frequent condition in this group of age. It is not a contraindication by itself, but requires a careful medical evaluation before beginning the exercise program. It is appropriate to initiate activity at modest duration and intensity with regimens that progress gradually over extended time intervals. Particularly in these circumstances, it is important to limit activity to what a patient feels is comfortable, progressing in small increments and prioritizing longer duration over higher exercise intensity. Absolute contraindications are mainly cardiovascular diseases: recent heart attack, unstable angina, uncontrolled hypertension, acute heart failure and blocking complete AV.^{62, 72}

The elderly are extensive users of both prescription and over-the-counter medications and they tend to use them chronically. These medications can have negative effects on performance and they can lead to increasing adverse effects. Clinicians should be alert to elderly taking statins, beta-blockers and vasodilators drugs.⁷³

The main risks of aerobic and strength training are the risk of musculoskeletal injuries and cardiovascular risk. Patients should be advised that muscle soreness is normal at first and should subside in a few weeks. If injury or illness interrupts an activity routine, resuming activity at a lower intensity level is possible once sufficient healing has occurred. Any potential risks of routine exercise do not outweigh its benefits, in the absence of a contraindication to exercise.

General recommendations for safety, particularly in the initial stages of exercise, include exercising with one other person, carrying a cell phone to facilitate calling for emergency help, well-lit and ventilated rooms and adhering to an activity level that is comfortable and with normal breathing.⁷⁴

These data support the notion that supervised or group settings may be preferable for elders, with regard to both safety and compliance. It is necessary to wear proper footwear and clothing, good nutrition and liquid intake and adequate sleep. Exercise machines have advantages for older, especially frail, as the range of motion is easier to control. Chair and

bed based exercise should be considered as a starting point and used by frail patients.

Older adults face multiple barriers to practice exercise regularly and therefore experience difficulties starting with a PA program and adhering to it. These barriers include lack of knowledge about the beneficial effects of PA, fear of falling and problems to find and get to an exercise facility near home.⁷⁵ A more structured environment with classes (e.g., yoga, pilates, dancing) or in a fitness center (with a trainer or specialized equipment) may provide a variety of activities that may engage the individual, but home-based exercise (e.g., jogging, using an exercise bike) may result in better adherence given low cost and convenience. Data are lacking in determining the optimal setting to perform exercise (e.g., outdoors versus indoors, home versus fitness center).^{76, 77} A systematic review of six trials evaluated the efficacy of home-based versus hospital (center)-based exercise programs in older adults.⁷⁷ In the short-term, center-based programs were superior to home-based programs in patients with peripheral vascular disease. However, in the long-term, home-based programs were superior to center-based programs in terms of adherence.

Health care providers are perceived as respected sources of health information and should thus take an active role in promoting PA. However, less than 50% of older adults report that their physicians have recommended exercise. The primary care setting would appear to be a good place for health promotion because most older adults visit their primary care provider more than once a year.⁴⁰ However, most observational studies and randomized trials have found conflicting results on whether usual counselling in a primary care setting is sufficient to effect behavioral change.^{78, 79}

Conclusions

In conclusion, motivating older persons to increase their physical activity level as well as providing safe access to exercise programs seems to be a mandatory task. Many previous authors have provided data and interpretation critical to understanding that muscle weakness, reduction in muscle mass and reduction in PA occur during life span and lead to sarcopenia and disability in some older people. PA, which is a modifiable lifestyle behavior, can par-

tially reverse this muscle dysfunction in the elderly, as well as benefit every part of the body and substantially extend independent functional lifespan. In addition to our traditional recommendations of the health benefits of exercise in young people, we should stress the harms of inactivity even in the oldest adults and view the inactive elder population as abnormal and consider them at high risk of disease and disabilities.⁸⁰

We would like to finish our review honoring Jeremy Morris, one of the first clinicians who advised about the health benefits of exercise, remembering his last investigation paper, published in 2009, some days before his dead at the age of 99:⁸¹ “We now know that regular physical activity of 150 minutes/week of moderate intensity physical activity reduces the risk of numerous chronic diseases, preserves health and function (both physical and mental) into old age, and extends longevity. The current challenge is to develop programs and interventions to promote physical activity for all in our increasingly sedentary societies”.

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