FACTSHEET

Sarcopenia/age-related muscle atrophy: Causes, prevention and therapy

Extent and causes of age-related muscle wasting

The ageing process is associated with a generalised and progressive loss of muscle mass and strength. From the age of 50, muscle mass decreases by around 1-2 % and muscle strength by 1.5-5% per year.[1] The loss of the fast-twitch type 2 muscle fibres progresses particularly rapidly.[2] This is associated with a decrease in functional capacity, which manifests itself, for example, in difficulties walking, standing up or carrying. Mobility and independence are increasingly impaired.[2]

A variety of complex age-related processes are responsible for muscle atrophy, including:

- Changes in hormonal balance
- Changes in muscle protein synthesis and degradation
- Neurodegeneration
- Increase in inflammatory factors
- Insulin resistance
- Decrease in the number and activation of satellite cells
- Oxidative stress.

Factors that promote muscle anabolism, such as insulin-like growth factor 1 (IGF-1) or testosterone, decrease. Factors that contribute to skeletal muscle breakdown, such as inflammatory cytokines, increase. In addition, with age, connective tissue and fat are increasingly deposited in and around the muscles. [2-4]

Sarcopenia: definition and methods of measurement

Sarcopenia is generally referred to as excessive, progressive, generalized loss of muscle mass, strength and function. Sarcopenia is now considered a skeletal muscle disease based on adverse muscle changes that occur throughout life. It is associated with an increased likelihood of adverse outcomes, such as falls, fractures, physical disability, and mortality.[5] As of 2018, sarcopenia has its own ICD-10-GM code: M62.50, which takes into account reduced functionality in addition to low muscle mass, which has long been the definitive diagnostic criterion. According to the commonly used 2018 European Working Group on Sarcopenia in Older People (EWGSOP2) definition of sarcopenia (Table 1.), reduced muscle strength is the primary diagnostic criterion because it better predicts adverse outcomes than muscle mass. Muscle strength is currently considered the most reliable measure of muscle function.[5]

1. Low muscle strength	Sarcopenia is likely to be present if muscle strength is low.
	Hand strength (men < 27 kg, women < 16 kg), chair-rising test (> 15 s for 5 times standing up)
2. Low muscle quantity/quality	The additional documentation of low muscle quantity or quality confirms the diagnosis.
	Bioelectrical impedance analysis (ASM: men < 20 kg, women < 15 kg; ASM/body size2: men < 7.0 kg/m2, women < 5.5kg/m2), Dual-energy X-ray absorptiometry, CT, MRI
3. Low physical fitness	If the physical capacity is also low, sarcopenia is considered severe.
	Gait speed (≤ 0.8 m/s), Short physical performance battery (≤ 8 points), Time-up-and-go test (≤ 20 s), 400-metre walk test (not completed or ≥ 6 min)

Table 1 Operational definition of sarcopenia, validated measurement methods/tests, and recommended sarcopenia thresholds according to EWGSOP2.[5]

Sarcopenia is common among seniors, with prevalence/frequency increasing with age. However, it can also affect younger people.[5,6] Sarcopenia is considered „primary" (or age-related) when no other specific cause of muscle wasting beyond aging is apparent. If other causative factors are present (or even in addition to aging), it is considered „secondary." These include systemic diseases such as cancer, endocrine, neurological, and especially inflammatory diseases.[5] In addition, physical inactivity, such as due to a sedentary lifestyle or immobility due to illness, as well as a poor diet with insufficient energy and/or protein intake, promote the development of sarcopenia.[4,5]

Consequences of sarcopenia

Sarcopenia is associated with a number of negative, often serious, consequences. For those affected, coping with everyday life becomes increasingly problematic. Sarcopenia leads to an increased risk of falls[7,8], impaired mobility[9], and progressive loss of independence[10] and quality of life[11,12]. Sarcopenia is a major cause of the geriatric syndrome frailty[13] and is associated with osteoporosis[12], type 2 diabetes[14], heart disease[1]5, respiratory disease[16], and cognitive impairment[17], among others. Sarcopenia is ultimately associated with disability[5], hospitalization[18], need for long-term care[19], and a 3.6-fold increase in mortality.[7]

Prevention and therapy of muscle atrophy in old age/sarcopenia

The most effective intervention for prevention and treatment of normal and excessive (sarcopenia) age-related muscle wasting is considered to be physical activity, specifically strength training (at least 2 to 3 times per week) - as also recommended in guidelines. It improves muscle strength, muscle mass, and physical performance.[4,6]

In adolescence and young adulthood, muscle mass and strength usually increase and reach maximum values, stagnate in midlife, and decrease again with advancing age. To best prevent or delay sarcopenia, muscle mass should be maximized in youth and young adulthood, maintained in middle age, and muscle loss minimized in older age (see Figure 1).[5,20] Regular strength training in middle to old age can slow muscle loss, prevent sarcopenia, and maintain physical functioning, mobility, independence, and quality of life for longer. It is also suitable for the treatment of existing sarcopenia.

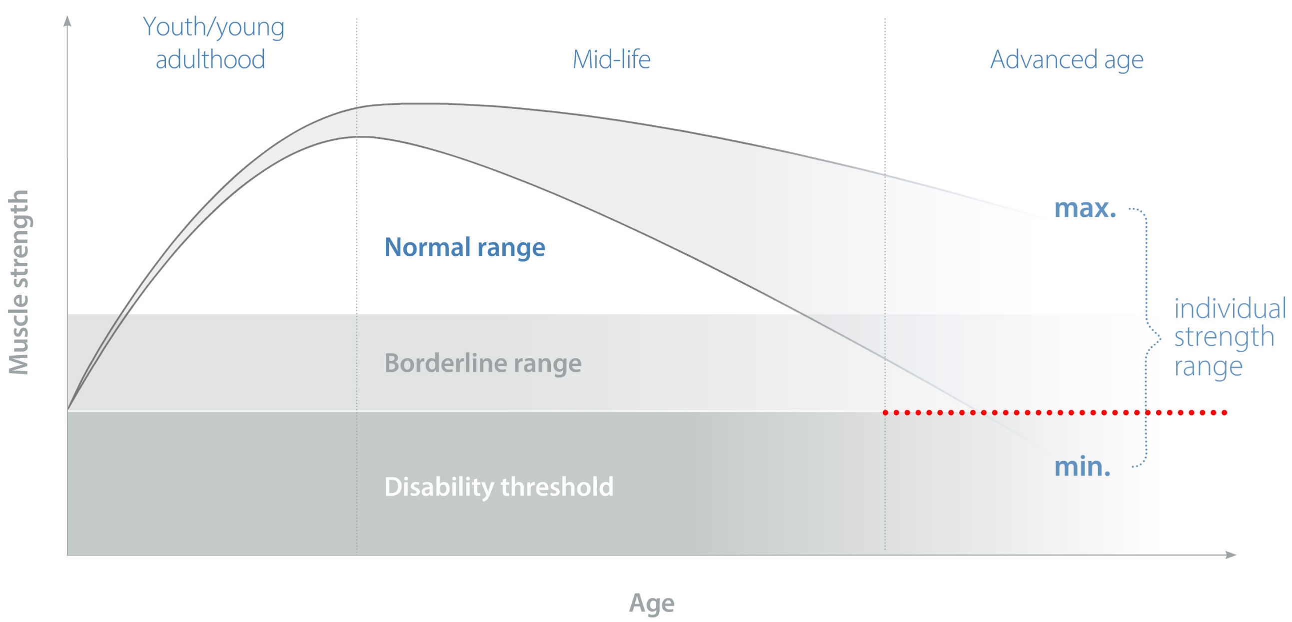

Figure 1: Muscle strength over the course of life (Fig. modified from Cruz-Jenthof AJ et al. 20195).

Medical whole body electromyostimulation (EMS training): Prevent muscle atrophy and sarcopenia

Not all older people are able to achieve the comparatively high stimulus intensity required in strength training for good muscle development and maintenance, or to perform conventional high-intensity strength training. Possible reasons for this are already advanced muscle atrophy, severe functional limitations and concomitant diseases. Many patients with sarcopenia and/or frailty, osteoporosis, osteoarthritis or heart problems also shy away from strength training with weights. They feel too weak, unstable and are afraid of falls and injuries. Furthermore, many people refuse to do strength training several times a week. In addition to a lack of motivation and convenience, a lack of time often plays a major role.[21,22]

For this group of people with little affinity for sports or already weakened, frail, multimorbid middle-aged and older people, technologically supported training in the form of medical electromyostimulation (EMS) is an attractive and equally effective option.[21,22] The application takes place under individual supervision in a 1:2 or 1:1 setting and, at 1 time per week for approximately 20 minutes, is a time-saving procedure in which the effect of light, subliminal physical exercises is amplified to an effective level and a high stimulus intensity is achieved. EMS also ensures immediate, continuous recruitment of type 2 muscle fibers.[21-24] Since no weights are used, medical EMS is particularly easy on the joints and subjectively less demanding.

The efficacy and safety of medical EMS for the prevention and therapy of age-related muscle atrophy and sarcopenia have been demonstrated in various studies. Among other things, it has been shown to have a positive effect on muscle mass, strength, function, functional performance, and abdominal fat.[25-29] At the molecular level, EMS provides modulation of factors, particularly IGF-1, that promote muscle protein biosynthesis, inhibit breakdown, and activate satellite cells.[30,31]

Sarkopenia	EMS	
▼	▲	Muscle strength
▼	▲	Muscle quantity and quality
▼	▲	Muscle function
▼	▲	Functional performance
▼	▲	Type 2 muscle fibres
▼	▲	Anabolic factors (e.g. insulin-like growth factor IGF-1, growth hormone G-)
▲	▼	Catabolic factors (e.g. myostatin)
▲	▼	Inter/intramuscular fat/connective tissue

▼▼ Decrease/Loss ▲▲ Increase/profit

Figure 2: The positive effects of EMS on age-related muscle loss/sarcopenia (Fig. modified after Blöckl J, Kemmler W, Schöne D. 202122).

Medical EMS thus provides an innovative, effective, safe, joint-friendly and time-efficient treatment concept for the long-term prevention and therapy of age-related muscle atrophy and sarcopenia.

References: **1** Keller K, Engelhardt M. Strength and muscle mass loss with aging process. Age and strength loss. Muscles Ligaments Tendons J. 2013; 3:346-350 **2** Lang T et al. Sarcopenia: etiology, clinical consequences, intervention, and assessment. Osteoporos Int. 2010; 21:543-559 **3** Frontera WR, Rodriguez Zayas A, Rodriguez N. Aging of human muscle: understanding sarcopenia at the single muscle cell level. Phys Med Rehabil Clin N Am. 2012; 23: 201-207 **4** Liguori I et al. Sarcopenia: assessment of disease burden and strategies to improve outcomes. Clin Interv Aging. 2018; 13: 913-927 **5** Cruz-Jenthof AJ et al. Sarcopenia: revised European consensus on definition and diagnosis. Age and Ageing. 2019; 48:16-31 **6** Dent E et al. International Clinical Practice Guidelines for Sarcopenia (ICFSR): Screening, Diagnose und Management. J Nutr Health Aging. 2018; 22:1148-1161 **7** Beaudart C et al. Health Outcomes of Sarcopenia: A Systematic Review and Meta-Analysis. PLoS One. 2017; 12: e0169548 **8** Schaap LA et al. Associations of sarcopenia definitions, and their components, with the incidence of recurrent falling and fractures: the longitudinal aging study Amsterdam. J Gerontol A Biol Sci Med Sci. 2018; 73: 1199-1204 **9** Morley JE et al. Sarcopenia with limited mobility: an international consensus. J Am Med Dir Assoc. 2011; 12: 403-409 **10** Dos Santos L et al. Sarcopenia and physical independence in older adults: the independent and synergic role of muscle mass and muscle function. J Cachexia Sarcopenia Muscle. 2017; 8: 245-250 **11** Beaudart C et al. Validation of the SarQoL(R), a specific health-related quality of life questionnaire for Sarcopenia. J Cachexia Sarcopenia Muscle. 2017; 8: 238-244 **12** Won Go L et al. Association between Sarcopenia, Bone Density, and Health-Related Quality of Life in Korean Men. Korean J Fam Med. 2013; 34: 281-288 **13** Morley JE. Frailty and Sarcopenia: The New Geriatric Giants. Rev Invest Clin. 2016; 68:59-67 **14** Sayer AA et al. Type 2 Diabetes, Muscle Strength, and Impaired Physical Function: The tip of the iceberg? Diabetes Care. 2005; 28:2541-2542 **15** Bahat G, Ilhan B. Sarcopenia and the cardiometabolic syndrome: a narrative review. Eur Geriatr Med. 2016; 6: 220-223 **16** Bone AE et al. Sarcopenia and frailty in chronic respiratory disease. Chron Respir Dis. 2017; 14:85-99 **17** Chang KV et al. Association between sarcopenia and cognitive impairment: a systematic review and meta-analysis. J Am Med Dir Assoc. 2016; 17:1164.e7-64.e15 **18** Cawthon PM et al. Clinical definitions of sarcopenia and risk of hospitalization in community-dwelling older men: the osteoporotic fractures in men study. J Gerontol A Biol Sci Med Sci. 2017; 72:1383-1389 **19** Akune T et al. Incidence of certified need of care in the long-term care insurance system and its risk factors in the elderly of Japanese population-based cohorts: the ROAD study. Geriatr Gerontol Int. 2014; 14:695-701 **20** Sayer AA et al. The developmental origins of sarcopenia. J Nutr Health Aging. 2008; 12:427-432 **21** Blöckl J, Kemmler W, Schöne D. Ganzkörper-EMS bei älteren, vulnerablen Menschen. Zeitschrift für Physiotherapeuten. Juli 2021 **22** Paillard T. Muscle plasticity of aged subjects in response to electrical stimulation training and inversion and/or limitation of the sarcopenic process. Ageing Research Reviews. Ageing Res Rev. 2018; 46:1-13 23 Gregory CM, Bickel CS. Recruitment patterns in human skeletal muscle during electrical stimulation. Phys Ther. 2005; 85:358-364 **24** Jubeau M et al. Comparison between voluntary and stimulated contractions of the quadriceps femoris for growth hormone response and muscle damage. J Appl Physiol. 2008; 104, 75-81 **25** Kemmler W et al. Whole-body electromyostimulation to fight sarcopenic obesity in community-dwelling older women at risk. Results of the randomized controlled FORMOsA-sarcopenic obesity study. Osteoporos Int. 2016; 27:3261-3270 **26** Kemmler W, von Stengel S. Whole-body electromyostimulation as a means to impact muscle mass and abdominal body fat in lean, sedentary, older female adults: subanalysis of the TEST-III trial. Clin Interv Aging. 2013; 8:1353-1364 **27** Teschler M et al. Four weeks of electromyostimulation improves muscle function and strength in sarcopenic patients: a three-arm parallel randomized trial. J Cachexia Sarcopenia Muscle. 2021; 12:843-854 **28** Kemmler W et al. Efficacy and Safety of Low Frequency Whole-Body Electromyostimulation (WB-EMS) to Improve Health-Related Outcomes in Non-athletic Adults. A Systematic Review. Front Physiol. 2018; 9:573 **29** Kemmler W, Schliffka R, von Stengel S. Effects of whole-body electromyostimulation on resting metabolic rate, body composition, and maximum strength in postmenopausal women: the Training and ElectroStimulation Trial. J Strength Cond Res. 2010; 24:1880-1887 **30** Kern H et al. Electrical Stimulation Counteracts Muscle Decline in Seniors. Front Aging Neurosci. 2014; 6:189 **31** Barberi L, Scicchitano BM, Musaro A. Mechanisms of Muscle Aging and Sarcopenia and Effects of Electrical Stimulation in Seniors. Eur J Transl Myol. 2015; 25:5227