
THE INTERPLAY OF PROTEIN INTAKE & PHYSICAL EXERCISE

Module 3

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THE INTERPLAY OF PROTEIN INTAKE & PHYSICAL EXERCISE



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INTRODUCTION

[1.1. Modifiable factors impacting muscle](#)

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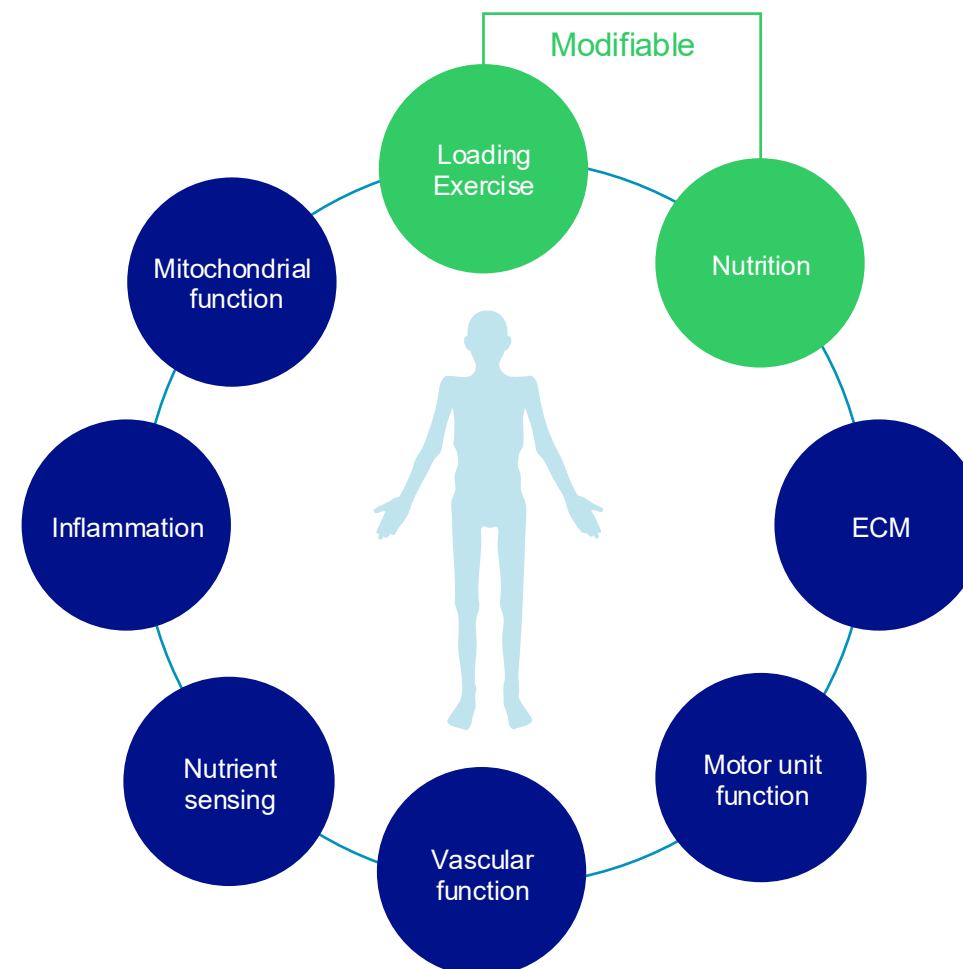
[1.3. Impact of exercise on muscle mass and strength](#)



INTRODUCTION

Modifiable factors impacting muscle

Among the various factors affecting muscle mass and function, protein intake and exercise are key as they are modifiable and can serve as tools to improve muscle health.¹



More information in Module 2.

1. Janssen TAH et al. From molecular to physical function: The aging trajectory. Curr Res Physiol. 2024 Dec 16;8:100138.

INTRODUCTION

Influence of exercise and nutrition in net protein balance

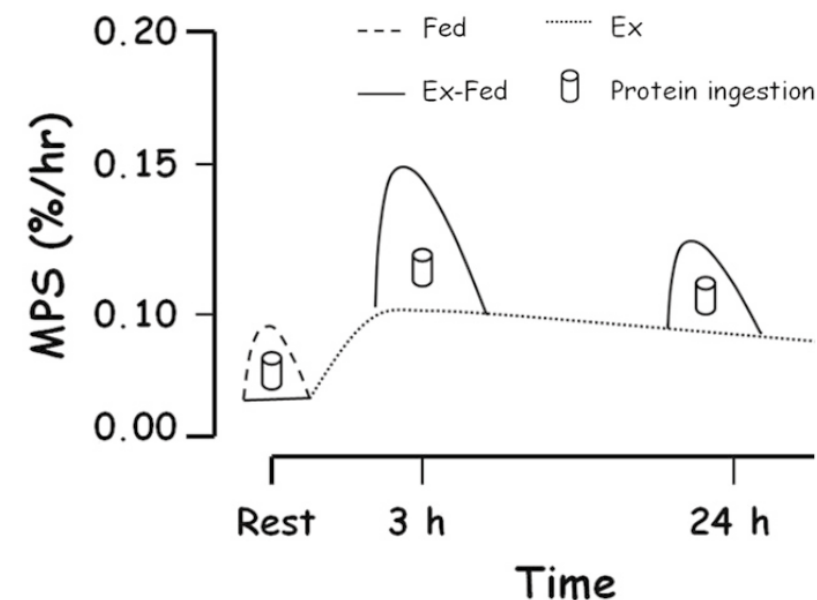
Resistance exercise sensitizes muscle to EAA provision.¹⁻³

After exercise:

- Greater stimulation of muscle protein synthesis (MPS) in the fed state, which is long-lasting
- Reduced suppression of MPS in the fasted state

Most trials have studied the effect of muscle and protein intake on MPS, and few have assessed their role in muscle protein breakdown (MPB).⁴

Resistance exercise increases MPB in untrained subjects but to a lesser extent than the MPS.⁵ Training diminishes the extent of MPB following resistance exercise.⁴



Resistance exercise increases the response to protein ingestion.³

More information in Module 3.

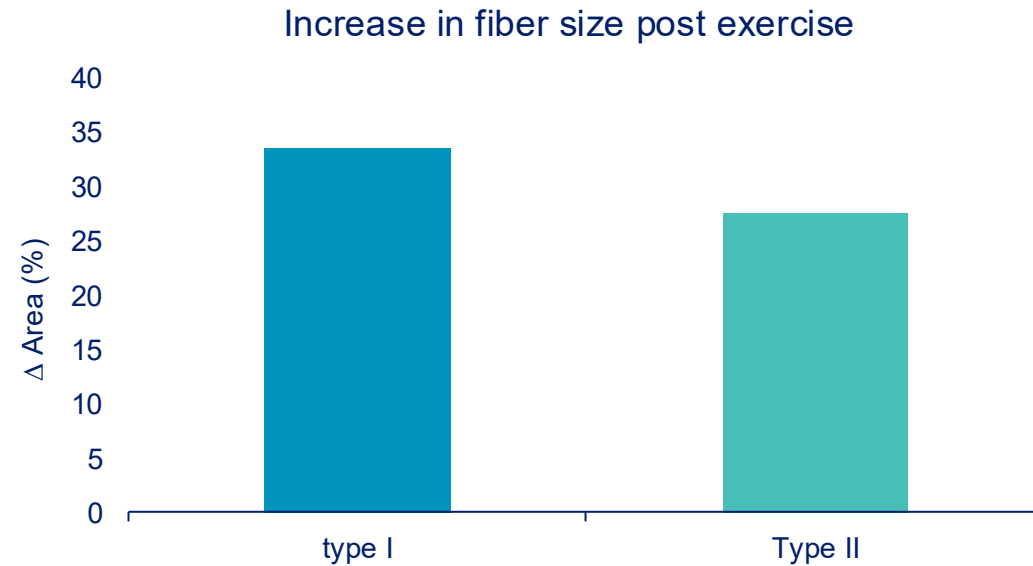
1. Breen L, et al. Skeletal muscle protein metabolism in the elderly: Interventions to counteract the 'anabolic resistance' of ageing. *Nutr Metab (Lond)*. 2011 Oct 5;8:68.
2. Yang Y, et al, Tarnopolsky MA, Phillips SM. Myofibrillar protein synthesis following ingestion of soy protein isolate at rest and after resistance exercise in elderly men. *Nutr Metab (Lond)*. 2012 Jun 14;9(1):57.
3. Churchward-Venne TA, et al. Nutritional regulation of muscle protein synthesis with resistance exercise: strategies to enhance anabolism. *Nutr Metab (Lond)*. 2012 May 17;9(1):40.
4. Tipton KD, et al. Assessing the Role of Muscle Protein Breakdown in Response to Nutrition and Exercise in Humans. *Sports Med*. 2018 Mar;48(Suppl 1):53-64.
5. Phillips SM, et al. Mixed muscle protein synthesis and breakdown after resistance exercise in humans. *Am J Physiol*. 1997 Jul;273(1 Pt 1):E99-107.

INTRODUCTION

Impact of exercise on muscle mass and strength

Exercise in elderly subjects results in:^{1,2}

- Muscle mass gain
- Increased strength
- Improved physical function
- Increased size of type I and type II muscle fibers



Effects of 12 weeks of resistance training on type I and type II fiber area of musculus vastus lateralis. Figure based on data described in¹

More information in Module 1.

1. Frontera WR, et al. Strength conditioning in older men: skeletal muscle hypertrophy and improved function. J Appl Physiol (1985). 1988 Mar;64(3):1038-44.

2. Mcleod JC, et al. The influence of resistance exercise training prescription variables on skeletal muscle mass, strength, and physical function in healthy adults: An umbrella review. J Sport Health Sci. 2024 Jan;13(1):47-60.



EXERCISE-RELATED MECHANISMS BEHIND MUSCLE SYNTHESIS & MAINTENANCE

[2.1. Impact of exercise on protein muscular synthesis](#)

[2.2. Exercise sensitizes muscle to leucine](#)

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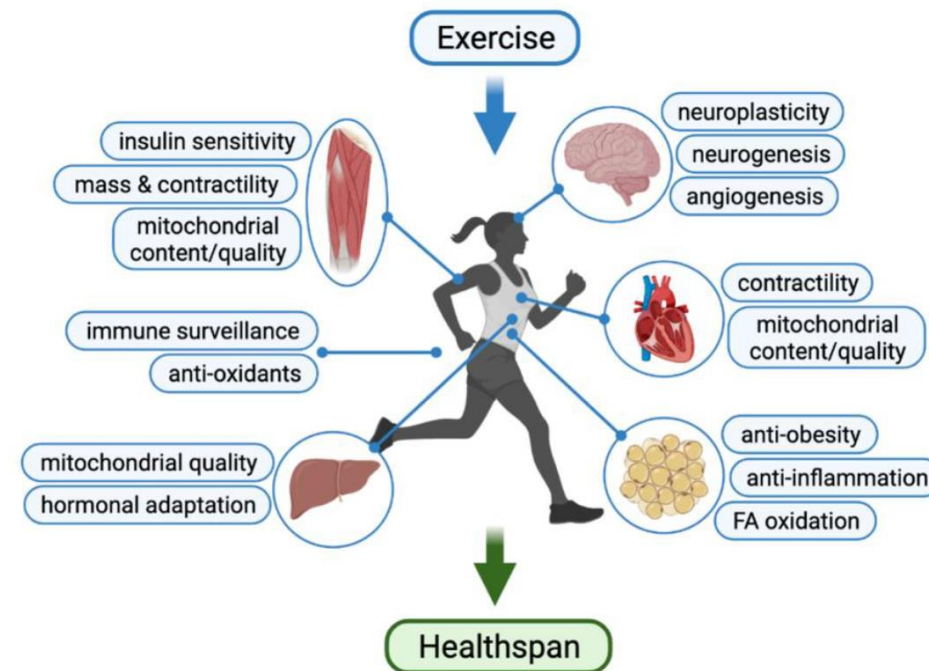
EXERCISE-RELATED MECHANISMS BEHIND MUSCLE SYNTHESIS & MAINTENANCE

Impact of exercise on protein muscular synthesis

Endurance and **resistance training** (ET and RT) increase muscular protein synthesis (MPS) in different ways.¹

RT has a greater stimulatory effect on **MPS**¹ thus, resulting in increased force-generating protein synthesis and increased **muscle mass** and **strength**.

ET has a greater stimulatory effect on **mitochondrial protein synthesis**,¹ thus resulting in enhanced **mitochondrial function**,² **cardiovascular health**³ and **insulin sensitivity**.⁴



Schematic showing the role of exercise in promoting healthy aging.⁵

More information in Module 2.

1. Wilkinson SB, et al. Differential effects of resistance and endurance exercise in the fed state on signalling molecule phosphorylation and protein synthesis in human muscle. J Physiol. 2008 Aug 1;586(15):3701-17.
 2. Koma R, et al. Endurance training increases mitochondrial myoglobin and enhances its interaction with complex IV in rat plantaris muscle. Acta Physiol (Oxf). 2024 May;240(5):e14139.
 3. Cornelissen VA, et al. Effects of endurance training on blood pressure, blood pressure-regulating mechanisms, and cardiovascular risk factors. Hypertension. 2005 Oct;46(4):667-75.
 4. Venables MC, et al. Endurance training and obesity: effect on substrate metabolism and insulin sensitivity. Med Sci Sports Exerc. 2008 Mar;40(3):495-502.
 5. Guan Y, et al. Molecular Mechanisms of Exercise and Healthspan. Cells. 2022 Mar 3;11(5):872.

EXERCISE-RELATED MECHANISMS BEHIND MUSCLE SYNTHESIS & MAINTENANCE

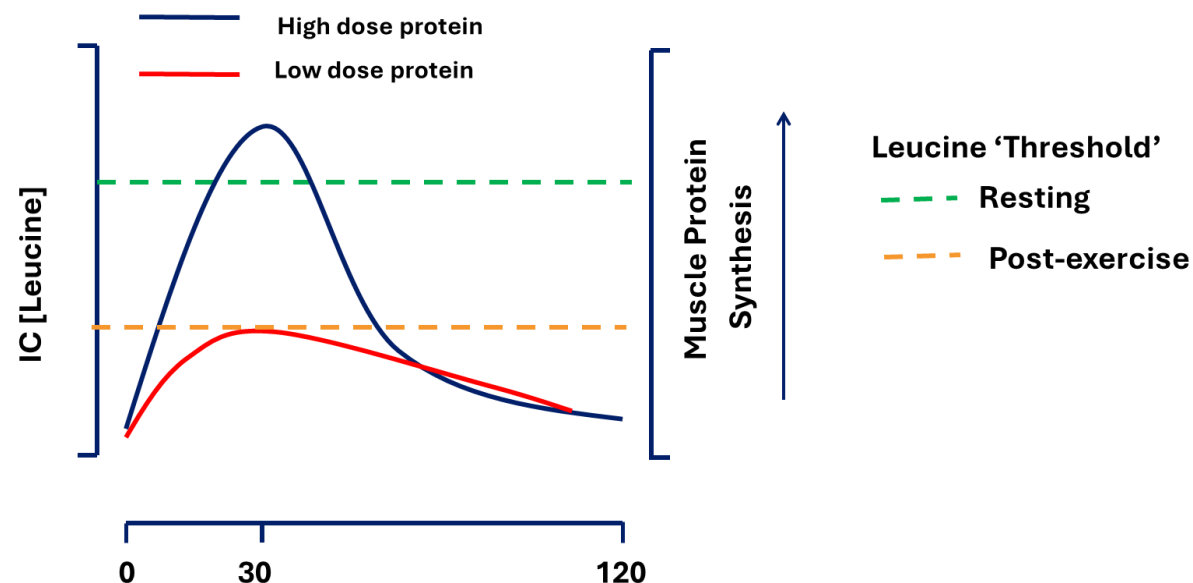
Exercise sensitizes muscle to leucine

Leucine is the key trigger amino acid for muscle protein synthesis (MPS) via activation of mTORC1.¹

Exercise lowers the threshold of leucine needed to stimulate MPS compared with rest.¹

After resistance exercise, smaller leucine increases lead to a greater MPS response.¹

Dietary proteins with higher leucine content and availability are more effective in stimulating MPS post-exercise.¹



Schematic representation of leucine threshold theory and the effect of exercise.¹

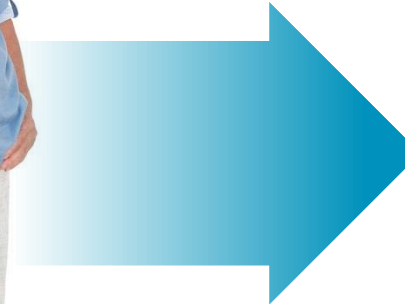
1. Phillips SM. The impact of protein quality on the promotion of resistance exercise-induced changes in muscle mass. *Nutr Metab (Lond)*. 2016 Sep 29;13:64.

Impact of endurance exercise on inflammation

Endurance exercise reduces inflammatory markers.¹

DID YOU KNOW?

Just about 100 minutes of walking per week for three months can lower signs of inflammation and oxidative stress in older adults who didn't exercise before.¹



↓ ROS

↓ Neutrophil activation

More information in Module 2.



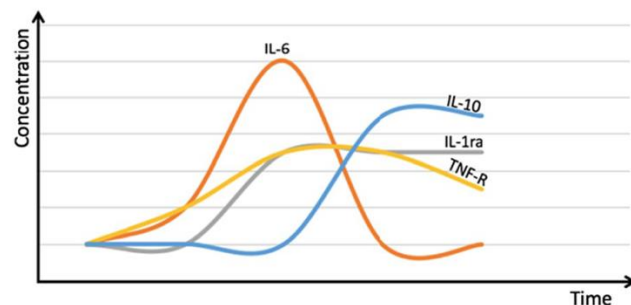
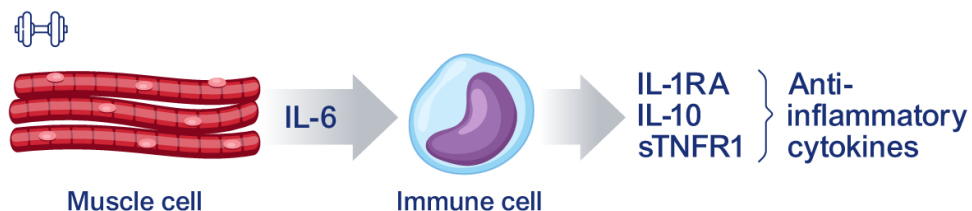
1. Suzuki K. Chronic Inflammation as an Immunological Abnormality and Effectiveness of Exercise. Biomolecules. 2019 Jun 7;9(6):223.

EXERCISE-RELATED MECHANISMS BEHIND MUSCLE SYNTHESIS & MAINTENANCE

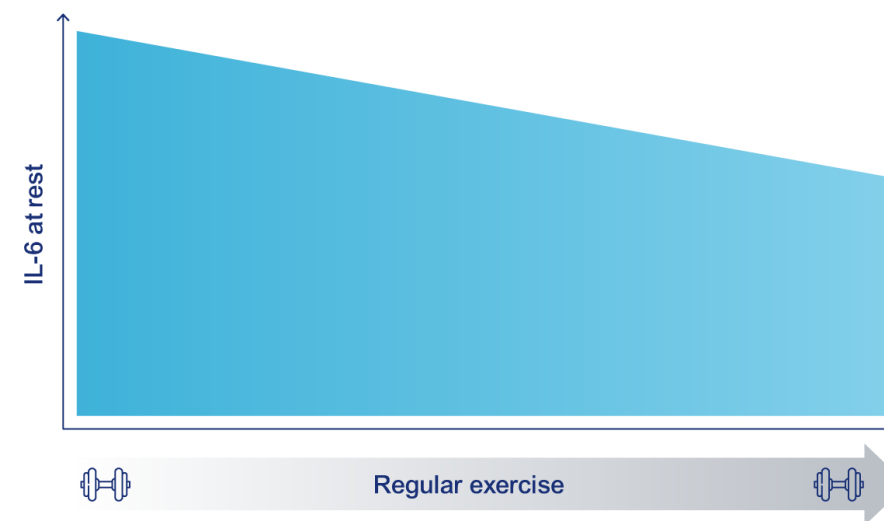
Impact of resistance exercise on inflammation

Resistance exercise leads to a **transient increase** in **IL-6**.^{1,2}

IL-6 stimulates anti-inflammatory cytokines like IL-10, IL-1RA and sTNFR1.¹⁻³



In the long-term regular resistance exercise reduces basal inflammation (lower IL-6 at rest). and increases IL-8², a cytokine which promotes angiogenesis.⁴



Impact of exercise on inflammation. Figure includes a figure from ³ and is also based on data described in ^{1,2}

1. Petersen AM, et al. The anti-inflammatory effect of exercise. J Appl Physiol (1985). 2005 Apr;98(4):1154-62.
 2. Forti LN, et al. Effects of resistance training at different loads on inflammatory markers in young adults. Eur J Appl Physiol. 2017 Mar;117(3):511-519.
 3. Docherty S, et al. The effect of exercise on cytokines: implications for musculoskeletal health: a narrative review. BMC Sports Sci Med Rehabil. 2022 Jan 6;14(1):5.
 4. Choi J, et al. FGF2-primed 3D spheroids producing IL-8 promote therapeutic angiogenesis in murine hindlimb ischemia. NPJ Regen Med. 2021 Aug 18;6(1):48.

EXERCISE-RELATED MECHANISMS BEHIND MUSCLE SYNTHESIS & MAINTENANCE

Impact of exercise on mitochondria

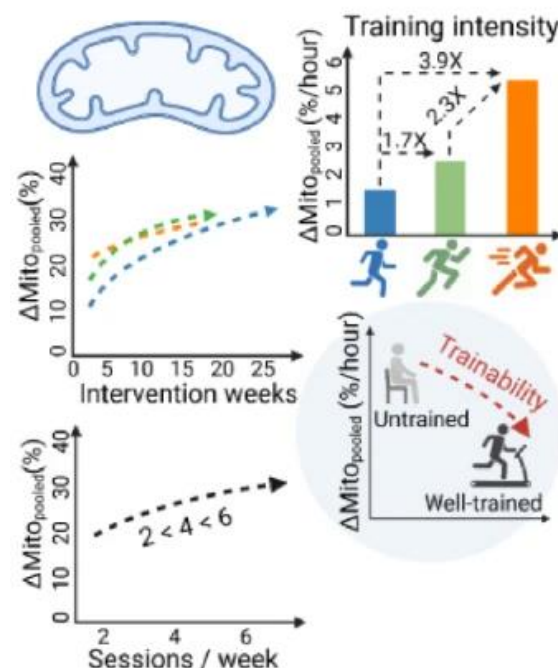
- All exercise types boost mitochondria:¹

All types of training significantly increase skeletal muscle mitochondrial content by about 23–27% on average.

- More frequent sessions of aerobic exercise yield bigger gains:

6 sessions per week gives larger mitochondrial increases than 4 or 2 sessions per week.

- People with lower starting fitness achieve the biggest mitochondrial gains.



Summary of the effects of exercise on mitochondria. $\text{Mito}_{\text{pooled}}$: Mix of 5 mitochondrial content markers. Figure modified from ¹

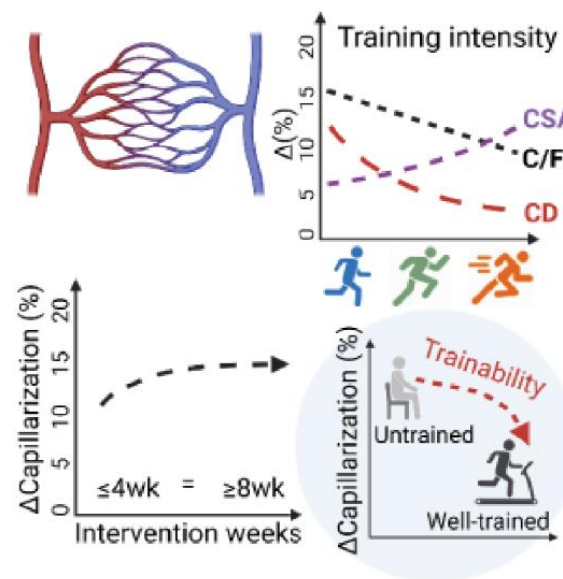
More information in Module 2.

EXERCISE-RELATED MECHANISMS BEHIND MUSCLE SYNTHESIS & MAINTENANCE

Impact of exercise on muscular capillarization

Exercise increases muscle capillaries:

- All training types (ET, HIT and SIT), increase the number of capillaries per muscle fiber by about 10–15% on average.
- Capillary density (capillaries per mm²) is highest with ET.
- The biggest improvements in capillarization occur within the first 4 weeks of training.
- Untrained and moderately trained individuals benefit most.



Summary of the effects of exercise on capillarity. CD: capillary density, C/F: capillaries per fiber, CSA: Cross-sectional area. Figure modified from ¹

More information in Module 2.

EXERCISE-RELATED MECHANISMS BEHIND MUSCLE SYNTHESIS & MAINTENANCE

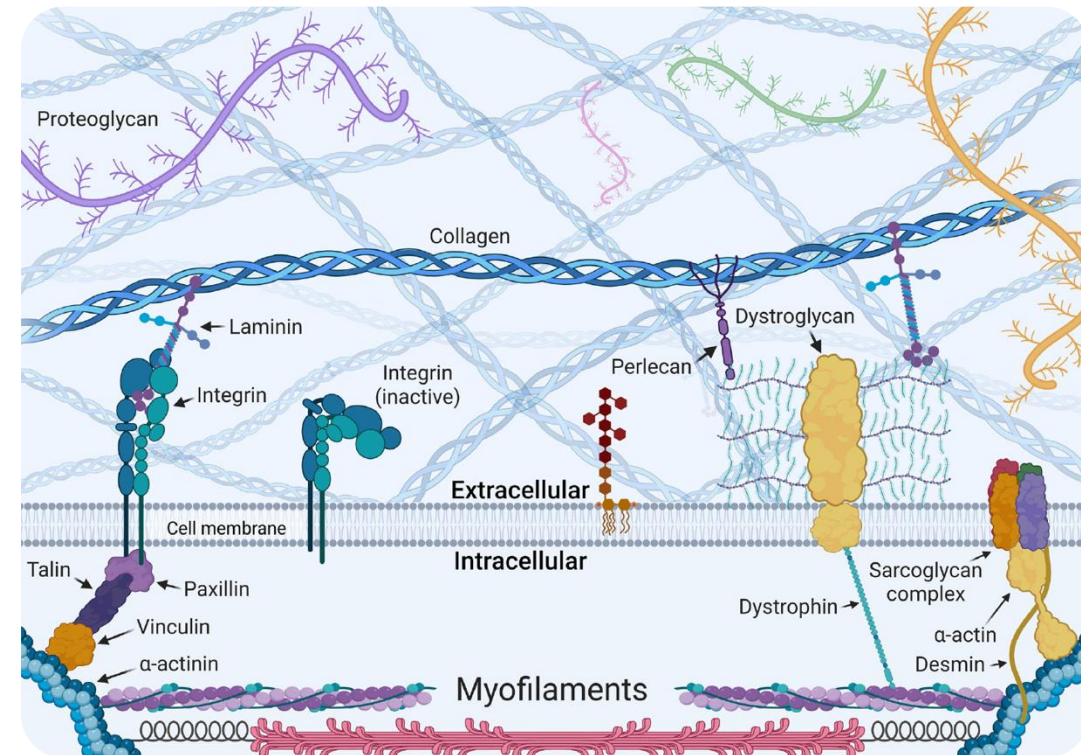
Impact of exercise on the extracellular matrix

Physical activity strongly affects the skeletal muscle ECM.¹

Regular activity promotes healthy ECM remodelling.¹

- Raises muscle collagen levels¹
- Activates matrix metalloproteinases (MMPs).²

Exercise enhances collagen turnover, replacing damaged older collagen.¹



Schematic representation of the ECM and some of its components.¹

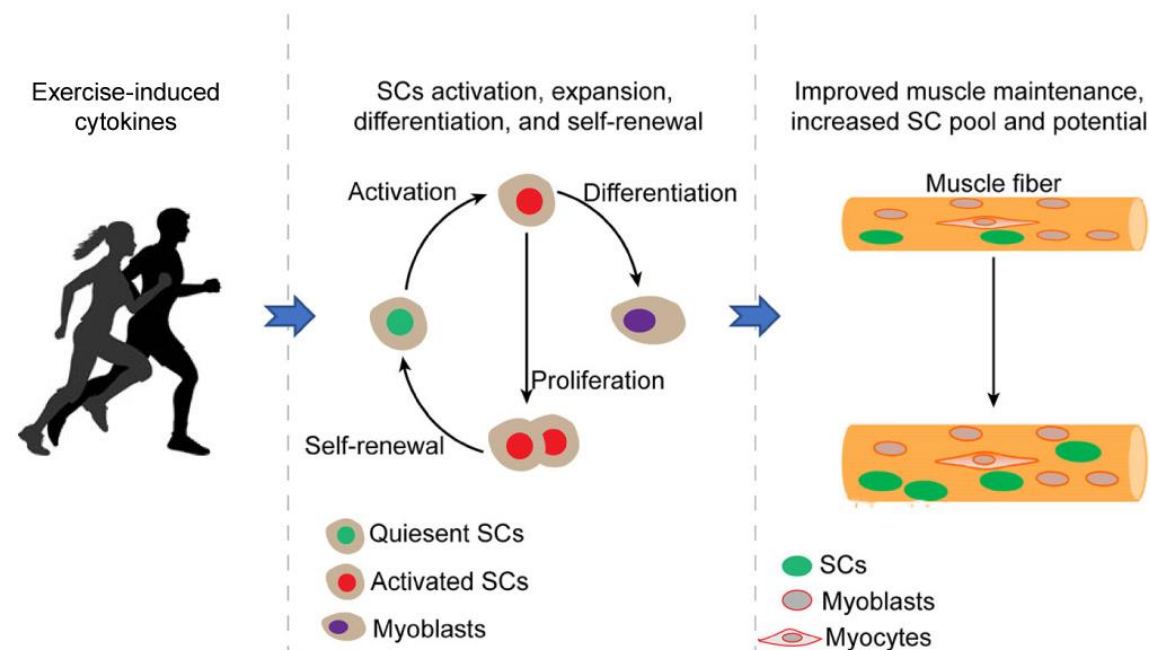
1. Mavropalias G, et al. Exercise builds the scaffold of life: muscle extracellular matrix biomarker responses to physical activity, inactivity, and aging. *Biol Rev Camb Philos Soc.* 2023 Apr;98(2):481-519.
 2. Rullman E, et al. Endurance exercise activates matrix metalloproteinases in human skeletal muscle. *J Appl Physiol* (1985). 2009 Mar;106(3):804-12.

EXERCISE-RELATED MECHANISMS BEHIND MUSCLE SYNTHESIS & MAINTENANCE

Impact of exercise on satellite cells

Resistance exercise (RE)¹ and endurance exercise² **increase** the number of **satellite cells** (SCs), with the increase being greater in younger adults than in the elderly.¹

Endurance training³ and RE⁴ lead to **SC activation**.



Schematic representation effect of exercise on satellite cells. Modified from ⁵

1. Dreyer HC, et al. Satellite cell numbers in young and older men 24 hours after eccentric exercise. *Muscle Nerve*. 2006 Feb;33(2):242-53.
 2. Charifi N, et al. Effects of endurance training on satellite cell frequency in skeletal muscle of old men. *Muscle Nerve*. 2003 Jul;28(1):87-92.
 3. Huang X, et al. Endurance exercise remodels skeletal muscle by suppressing Ythdf1-mediated myostatin expression. *Cell Death Dis*. 2025 Feb 13;16(1):96.
 4. Mackey AL, et al. Enhanced satellite cell proliferation with resistance training in elderly men and women. *Scand J Med Sci Sports*. 2007 Feb;17(1):34-42.
 5. Guo Q, et al. Control of muscle satellite cell function by specific exercise-induced cytokines and their applications in muscle maintenance. *J Cachexia Sarcopenia Muscle*. 2024 Apr;15(2):466-476.

EXERCISE-RELATED MECHANISMS BEHIND MUSCLE SYNTHESIS & MAINTENANCE

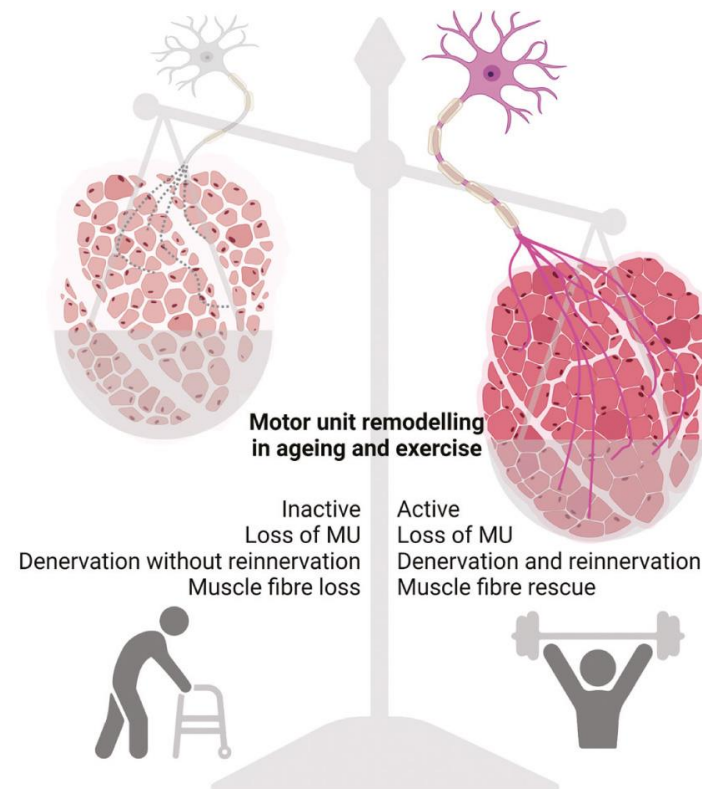
Impact of exercise on motor unit remodeling

Motor units (MU) are highly plastic.¹

MU remodeling compensates for MU number reduction via fiber reinnervation.¹

Resistance exercise training induces MU remodeling by impacting neural adaptations:¹

- Increase MU firing rate
- Lower MU recruitment thresholds
- Stimulate formation of new axonal sprouts



Schematic representation of motor unit remodeling in ageing and exercise.¹

[More information in Module 2.](#)

1. Dreyer HC, et al. Satellite cell numbers in young and older men 24 hours after eccentric exercise. *Muscle Nerve*. 2006 Feb;33(2):242-53.
 2. Charifi N, et al. Effects of endurance training on satellite cell frequency in skeletal muscle of old men. *Muscle Nerve*. 2003 Jul;28(1):87-92.
 3. Huang X, et al. Endurance exercise remodels skeletal muscle by suppressing Ythdf1-mediated myostatin expression. *Cell Death Dis*. 2025 Feb 13;16(1):96.
 4. Mackey AL, et al. Enhanced satellite cell proliferation with resistance training in elderly men and women. *Scand J Med Sci Sports*. 2007 Feb;17(1):34-42.
 5. Guo Q, et al. Control of muscle satellite cell function by specific exercise-induced cytokines and their applications in muscle maintenance. *J Cachexia Sarcopenia Muscle*. 2024 Apr;15(2):466-476.

EXERCISE-RELATED MECHANISMS BEHIND MUSCLE SYNTHESIS & MAINTENANCE

Summary

- ✓ Endurance & resistance **training boost muscle protein** synthesis in different protein pools.
- ✓ Resistance training **enhances** the **sensitivity** of muscle **to amino acid**, stimulating MPS and supporting muscle mass gains.
- ✓ Physical activity **lowers inflammation & oxidative stress** in older adults.
- ✓ Exercise **increase mitochondria** (~23–27%); more frequent sessions & lower starting fitness ➡ bigger gains.
- ✓ Exercise **increases** muscle **capillary density** — biggest gains in first 4 weeks, especially with endurance training.
- ✓ Regular exercise **remodels and renews muscle extracellular matrix**.
- ✓ Training **increases satellite cells** & their activation, more so in younger adults.
- ✓ Resistance exercise positively impacts on motor units: raises firing rate, lowers recruitment threshold, and **stimulates reinnervation**.





EXERCISE IN COMBINATION WITH ADEQUATE PROTEIN INTAKE SLOWS MUSCLE LOSS

[3.1. Protein and exercise: separate vs. combined effects on muscle](#)

[3.2. Factors influencing the effect of protein + exercise on muscle](#)

[3.3. Effect of high-quality protein intake plus resistance exercise on muscle protein synthesis](#)

[3.4. The impact of protein dose on exercise-induced muscle protein synthesis](#)

[3.5. Does timing of protein ingestion relative to exercise performance influence muscle outcomes?](#)

[3.6. Summary](#)



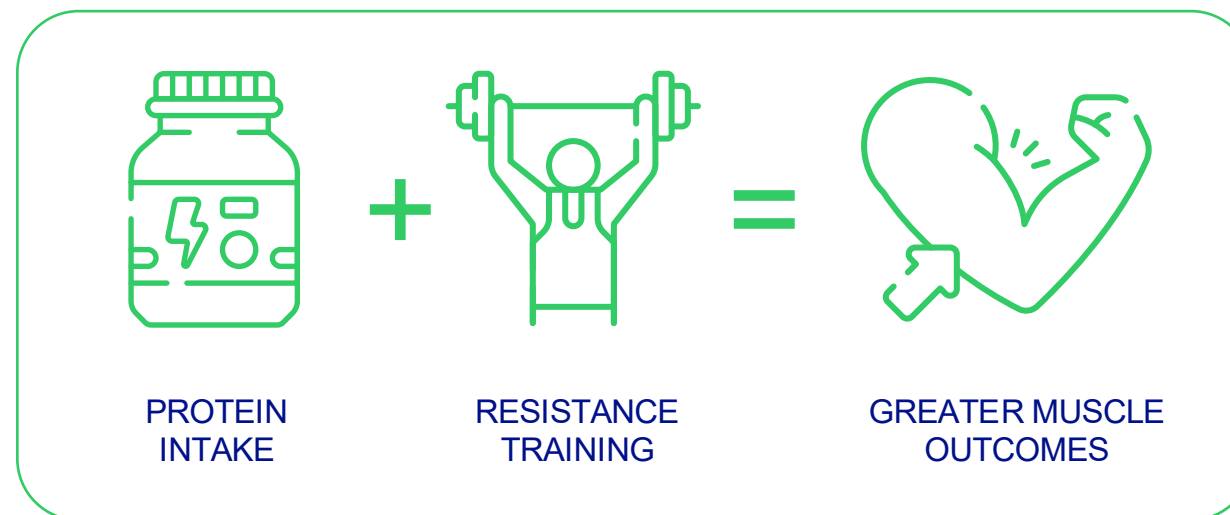
EXERCISE IN COMBINATION WITH ADEQUATE PROTEIN INTAKE SLOWS MUSCLE LOSS

Protein and exercise: separate vs. combined effects on muscle

Strong evidence supports **resistance exercise** for **improving muscle mass** and **strength** among older adults.^{1,2}

Protein supplementation plus resistance training promotes muscle mass and strength gain and improved physical function in frail older adults.³

Protein supplementation in adults and elderly **increases resistance training** induced gains in free fat mass (FFM) and **strength**.^{4,5}

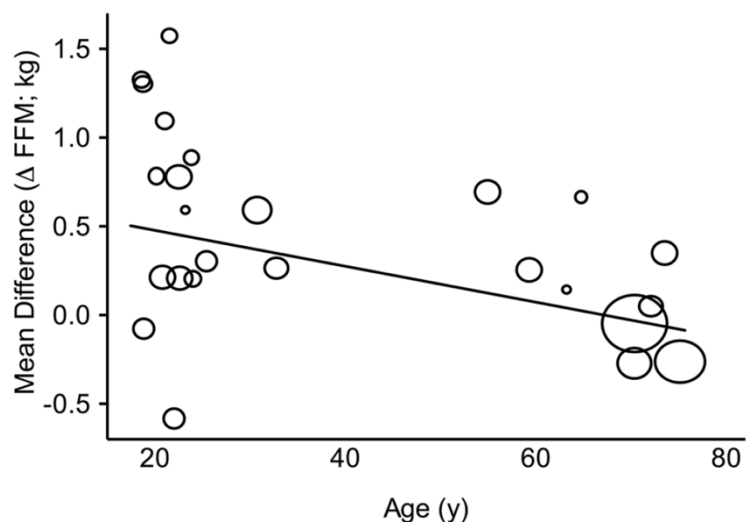


1. Peterson MD, et al. Resistance exercise for muscular strength in older adults: a meta-analysis. Ageing Res Rev. 2010 Jul;9(3):226-37.
 2. Radaelli R, et al. Effects of Resistance Training Volume on Physical Function, Lean Body Mass and Lower-Body Muscle Hypertrophy and Strength in Older Adults: A Systematic Review and Network Meta-analysis of 151 Randomised Trials. Sports Med. 2025 Jan;55(1):167-192.
 3. Liao CD, et al. The Role of Muscle Mass Gain Following Protein Supplementation Plus Exercise Therapy in Older Adults with Sarcopenia and Frailty Risks: A Systematic Review and Meta-Regression Analysis of Randomized Trials. Nutrients. 2019 Jul 25;11(8):1713.
 4. Morton RW, et al. A systematic review, meta-analysis and meta-regression of the effect of protein supplementation on resistance training-induced gains in muscle mass and strength in healthy adults. Br J Sports Med. 2018 Mar;52(6):376-384..
 5. Cermak NM, et al. Protein supplementation augments the adaptive response of skeletal muscle to resistance-type exercise training: a meta-analysis. Am J Clin Nutr. 2012 Dec;96(6):1454-64.

EXERCISE IN COMBINATION WITH ADEQUATE PROTEIN INTAKE SLOWS MUSCLE LOSS

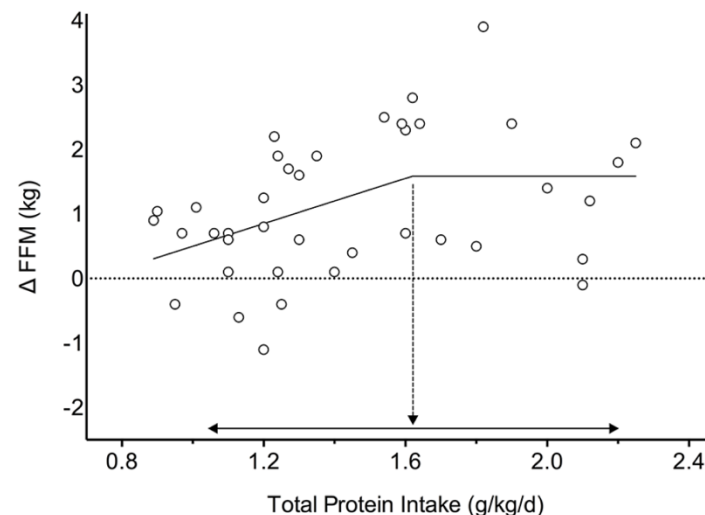
Factors influencing the effect of protein + exercise on muscle

Age: Protein + exercise synergy is less effective with increasing age.¹



Relationship between age and fat-free mass (FFM) difference. Circle size represent study weight.¹

Total protein intake: Protein intake above ~1.6 g/kg/day does not further increase FFM gain.¹



Relationship between protein intake and change in fat-free mass.¹

1. Morton RW, et al. A systematic review, meta-analysis and meta-regression of the effect of protein supplementation on resistance training-induced gains in muscle mass and strength in healthy adults. Br J Sports Med. 2018 Mar;52(6):376-384.



EXERCISE IN COMBINATION WITH ADEQUATE PROTEIN INTAKE SLOWS MUSCLE LOSS

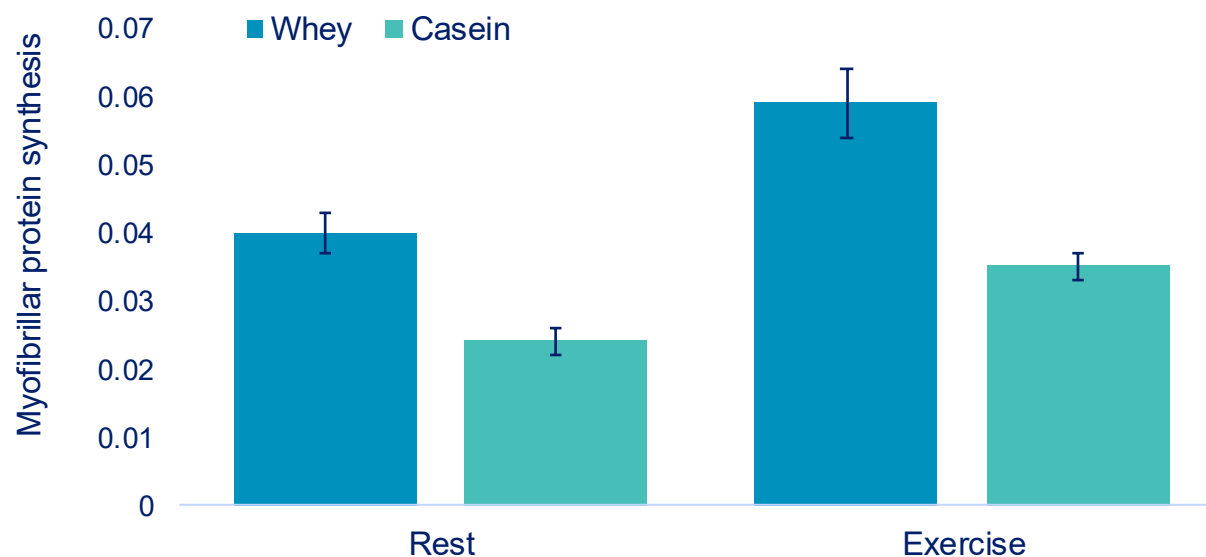
Effect of high-quality protein intake plus resistance exercise on muscle protein synthesis

Whey intake results in myofibrillar protein synthesis (MPS) than casein at rest, and MPS is further increased when resistance exercise is followed by protein ingestion.^{1,2}

Potentially due to the slower digestion rate of casein.³

The additive effects of protein intake and resistance exercise are observed in both young¹ and older adults.²

The superior effect of whey is believed to be due to the faster digestion rate of whey and the higher leucine content.



Myofibrillar protein synthesis (MPS). Subjects performed a bout of leg resistance exercise followed by the intake of a drink containing 20 g of protein. MPS was assessed 240 min after protein intake. Figure based on data described in ²

[More information in Module 3.](#)

1. Tang JE, et al. Ingestion of whey hydrolysate, casein, or soy protein isolate: effects on mixed muscle protein synthesis at rest and following resistance exercise in young men. J Appl Physiol (1985). 2009 Sep;107(3):987-92.
 2. Burd NA, et al. Greater stimulation of myofibrillar protein synthesis with ingestion of whey protein isolate v. micellar casein at rest and after resistance exercise in elderly men. Br J Nutr. 2012 Sep 28;108(6):958-62.
 3. Pennings B, et al. Whey protein stimulates postprandial muscle protein accretion more effectively than do casein and casein hydrolysate in older men. Am J Clin Nutr. 2011 May;93(5):997-1005.

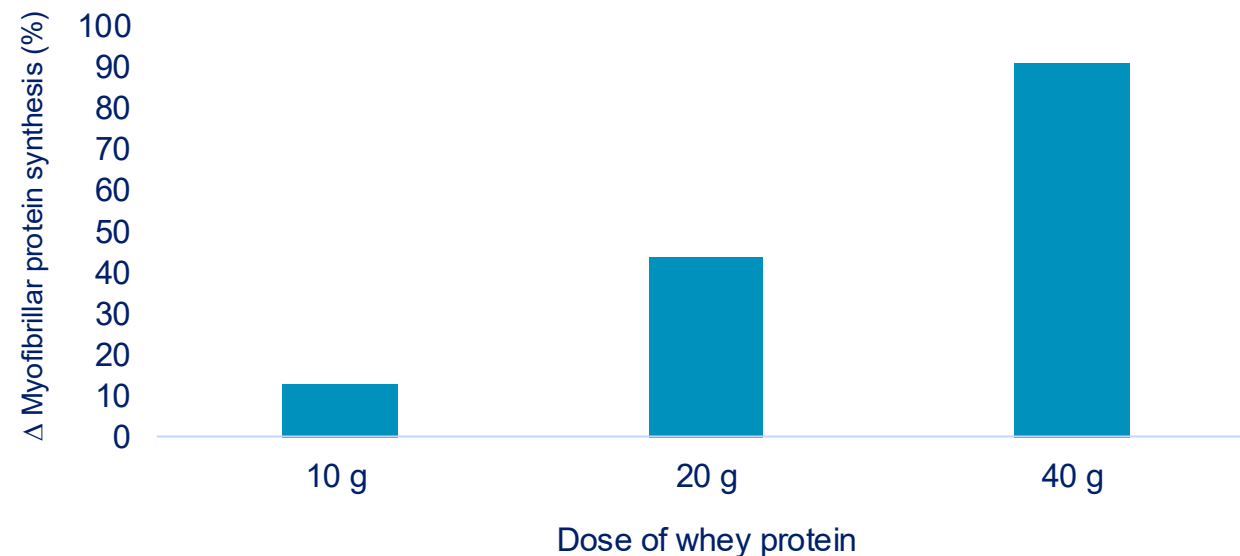
EXERCISE IN COMBINATION WITH ADEQUATE PROTEIN INTAKE SLOWS MUSCLE LOSS

The impact of protein dose on exercise-induced muscle protein synthesis

Resistance exercise enhances myofibrillar protein synthesis in a dose-dependent manner.^{1,2}

Young men did not experience further increases in MPS beyond a 20 g dose of whey protein.²

In older adults, ingestion of 20 g of whey protein increased MPS at rest. While 40 g did not further enhance MPS in the resting state, it significantly elevated MPS when consumed after exercise.¹



Myofibrillar protein synthesis (MPS) in elderly men. Subjects performed a bout of leg resistance exercise followed by the intake of whey protein isolate (0, 10, 20 or 40 g). MPS was measured 4 h after protein intake. Figure based on data described in ¹

1. Yang Y, et al. Resistance exercise enhances myofibrillar protein synthesis with graded intakes of whey protein in older men. Br J Nutr. 2012 Nov 28;108(10):1780-8.

2. Witard OC, et al. Myofibrillar muscle protein synthesis rates subsequent to a meal in response to increasing doses of whey protein at rest and after resistance exercise. Am J Clin Nutr. 2014 Jan;99(1):86-95.



EXERCISE IN COMBINATION WITH ADEQUATE PROTEIN INTAKE SLOWS MUSCLE LOSS

Does timing of protein ingestion relative to exercise performance influence muscle outcomes?

Combining essential amino acids + carbohydrates with exercise **enhances** the muscle **anabolic response** in young adults.¹

While these early studies suggested that nutrient timing was a key determinant of the anabolic response more recent evidence indicates that the overall effect of protein timing is less critical than once thought.¹⁻⁴

Systematic reviews and meta-analyses show that total daily protein intake plays a greater role than precise timing in influencing muscle anabolic response.⁵⁻⁷



1. Tipton KD, et al. Timing of amino acid-carbohydrate ingestion alters anabolic response of muscle to resistance exercise. *Am J Physiol Endocrinol Metab*. 2001 Aug;281(2):E197-206.
2. Esmarck B, et al. Timing of postexercise protein intake is important for muscle hypertrophy with resistance training in elderly humans. *J Physiol*. 2001 Aug 15;535(Pt 1):301-11.
3. Hoffman JR, et al. Effect of protein-supplement timing on strength, power, and body-composition changes in resistance-trained men. *Int J Sport Nutr Exerc Metab*. 2009 Apr;19(2):172-85.
4. Nabuco HCG, et al. Effects of Whey Protein Supplementation Pre- or Post-Resistance Training on Muscle Mass, Muscular Strength, and Functional Capacity in Pre-Conditioned Older Women: A Randomized Clinical Trial. *Nutrients*. 2018 May 3;10(5):563.
5. Schoenfeld BJ, et al. The effect of protein timing on muscle strength and hypertrophy: a meta-analysis. *J Int Soc Sports Nutr*. 2013 Dec 3;10(1):53.
6. Wirth J, et al. The Role of Protein Intake and its Timing on Body Composition and Muscle Function in Healthy Adults: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *J Nutr*. 2020 Jun 1;150(6):1443-1460.
7. Lak M, et al. Timing matters? The effects of two different timing of high protein diets on body composition, muscular performance, and biochemical markers in resistance-trained males. *Front Nutr*. 2024 May 23;11:1397090.

EXERCISE IN COMBINATION WITH ADEQUATE PROTEIN INTAKE SLOWS MUSCLE LOSS

Summary

- ✓ Resistance exercise effectively improves muscle mass and strength in older adults.
- ✓ High-quality protein intake facilitates muscle growth induced by exercise.
- ✓ Protein intake combined with resistance exercise exerts an additive effect on muscle mass.
- ✓ The optimal timing of protein intake alongside resistance exercise is less critical than once thought.





SCIENTIFIC RECOMMENDATIONS

[4.1. ESPEN recommendations](#)

[4.2. Exercise recommendations for older adults with physical disability](#)

[4.3. Examples of exercise recommendations for older adults with physical disability](#)

[4.4. Exercise prescription evolves with aging](#)

ESPEN recommendations

Lower protein intake

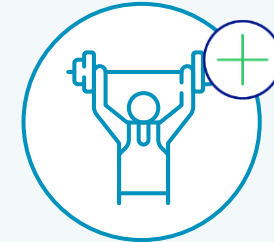
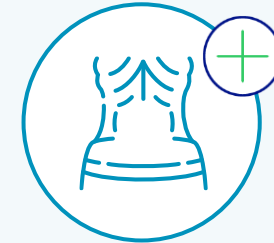
- Genetic predisposition
- Physiological changes
- Medical conditions
- Physical disability & mental disorders
- Socioeconomic conditions

Higher protein needs

- Anabolic resistance
- Low postprandial aa availability
- Decreased muscle perfusion
- Disease related protein catabolism
- Sarcopenia



RECOMENDATIONS



ESPEN recommendations

Lower protein intake

- Genetic predisposition
- Physiological changes
- Medical conditions
- Physical disability & mental disorders
- Socioeconomic conditions

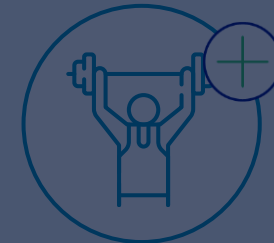
Higher protein needs

- Anabolic resistance
- Low postprandial aa availability
- Decreased muscle perfusion
- Disease related protein catabolism
- Sarcopenia



For healthy older people, the diet should provide at least 1.0 to 1.2 g protein/kg body weight/day.

RECOMENDATIONS



ESPEN recommendations

Lower protein intake

- Genetic predisposition
- Physiological changes
- Medical conditions
- Physical disability & mental disorders
- Socioeconomic conditions

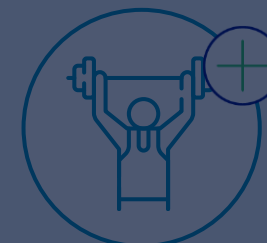
Higher protein needs

- Anabolic resistance
- Low postprandial aa availability
- Decreased muscle perfusion
- Disease related protein catabolism
- Sarcopenia



For older people who are malnourished or at risk of malnutrition because they have acute or chronic illness, the diet should provide 1.2 to 1.5 g protein/kg body weight/day, with even higher intake for individuals with severe illness or injury.

RECOMENDATIONS



ESPEN recommendations

Lower protein intake

- Genetic predisposition
- Physiological changes
- Medical conditions
- Physical disability & mental disorders
- Socioeconomic conditions

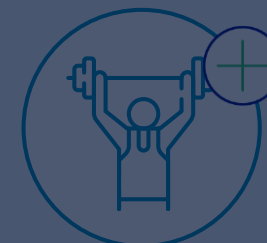
Higher protein needs

- Anabolic resistance
- Low postprandial aa availability
- Decreased muscle perfusion
- Disease related protein catabolism
- Sarcopenia



Daily physical activity or exercise (resistance training, aerobic exercise) should be undertaken by all older people, for as long as possible.”

RECOMENDATIONS



SCIENTIFIC RECOMMENDATIONS

Exercise recommendations for older adults with physical disability

It is key to personalize exercise prescriptions adjusting volume intensity and specific adaptations to patient needs according to their condition and comorbidities.¹

For that, the Nestlé HealthScience offers various resources for professionals responsible for the prescription of physical exercise which:^{2,3}

- Cover both healthy aging and frail patients^{2,3}
- Are available for health care professionals and consumers
- Are available in brochure³ and videos²
- Are available in different countries' websites including the USA, Spain and Singapore², among others.



Exercise programs
tailored by functional level

Tailored training program¹



Cardio exercise
(Endurance)



Flexibility



Strength & power
(Resistance)



Balance and walking



1. Izquierdo M, et al. Global consensus on optimal exercise recommendations for enhancing healthy longevity in older adults (ICFSR). J Nutr Health Aging. 2025 Jan;29(1):100401.
2. Nestlé HealthScience. Nutrition and motion: improve your strength. Available from: <https://www.nestlehealthscience.sg/health-management/aging/healthy-living/nutrition-and-motion> [Accessed 24-10-2025]
3. Nestlé HealthScience. Nutrition, Motion & Go – Simple Exercises for Your Patients. Available from: <https://www.nestlehealthscienceprofessional.com/nutrition-motion-go-simple-exercises-your-patients> [Accessed 30-03-2026]

SCIENTIFIC RECOMMENDATIONS

Examples of exercise recommendations for older adults with physical disability (1/2)



Walking (Endurance)

Advise your patient to:

- Stand up from the chair with the help of a person or a walker,
- Walk for 5 seconds,
- Pause for a brief standing rest of 10 seconds, then resume walking,
- Repeat this **cycle 5 times**.

When you notice that the patient's ability to walk has improved, you can then intensify the exercises.

The cardio programme will **only** be started when the older person has **improved** their **muscle strength**.



Strength (Resistance)

Advise your patient to:

- Establish the weight*
- Sit with arms stretched at the sides of the chest and a dumbbell in each hand.
- Bend the arm at the elbows till they reach the chest, directing the weights to the shoulders.
- Start with 1 set of 10 repetitions.
- Take a break of at least one minute but no longer than 3 minutes,
- Repeat another set of 10 repetitions.

* The weight should allow the subjects to perform the exercise correctly and without interruptions about 30 times. It should be enough for them to feel that they have made an effort upon completing the exercise.

SCIENTIFIC RECOMMENDATIONS

Examples of exercise recommendations for older adults with physical disability (2/2)



Balance

Advise your patient to:

- Stand up near a table, wall or family member,
- Place the heel of one foot in contact with the tip of the other foot.
- Walk a set of 10 steps. Stop and rest for 10 seconds without sitting,
- Take a break of at least one minute but no longer than 3 minutes and repeat.



Stretching (Flexibility)

Advise your patient to:

- Stretch the arms up with the hands interlinked, reaching up to the ceiling.
- Hold the position for 10-12 seconds.
- Then pause and relax the arms for 5 seconds.

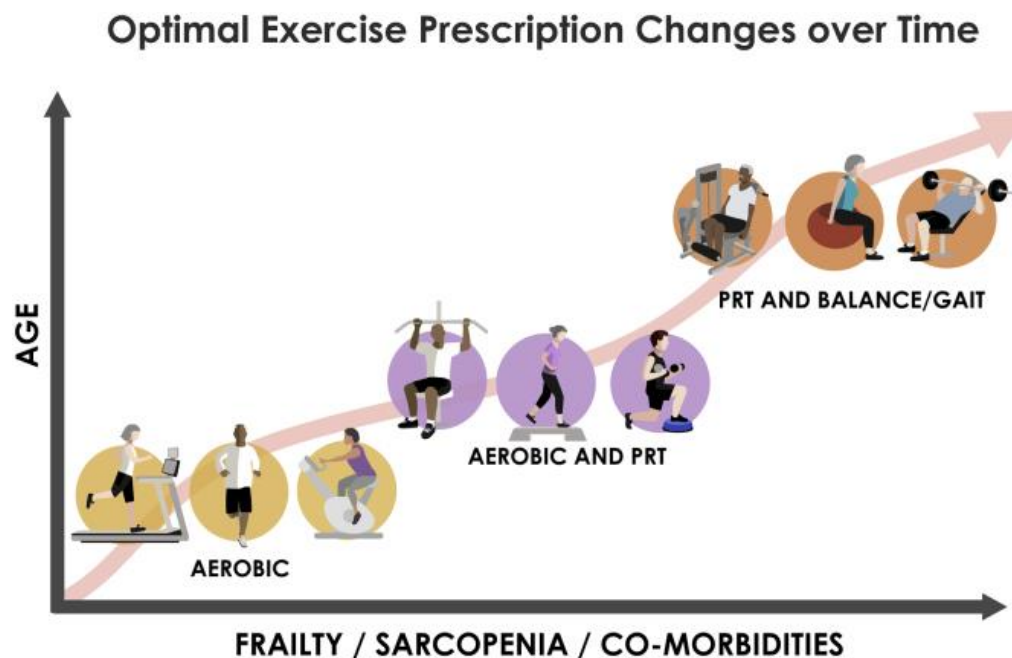
Start with 1 set of 3 repetitions, take a break of at least one minute but no longer than 3 minutes and repeat another set of 3 repetitions

SCIENTIFIC RECOMMENDATIONS

Exercise prescription evolves with aging

Transition from aerobic focus to strength and balance:¹

- **Early adulthood:** Aerobic training dominates for cardiovascular health and endurance. In advanced age, high-intensity aerobic training is often not feasible.
- **Middle age:** Combination of aerobic + progressive resistance training (PRT) becomes essential to preserve muscle and prevent sarcopenia muscle mass and function declines with age.
- **Older adults:** PRT, balance, and gait training gain priority as functional autonomy and fall prevention become critical.



Recommended type of exercises depending on age.¹





CONCLUSIONS

CONCLUSIONS

- ✓ **Protein** intake **and** resistance **exercise** are key modifiable factors that **contribute additively** to improvements in muscle mass and function.
- ✓ Resistance **exercise sensitizes muscle to protein intake** (e.g., via LeuRS and mTORC1), improving the anabolic response in muscle.
- ✓ Exercise has a positive impact on mitochondrial content, ECM remodeling, inflammation, motor unit remodeling.
- ✓ The muscle-related **benefits** of combining protein intake and exercise are **reduced in older adults**.
- ✓ Pre- and post-exercise protein intake have additive effects on muscle mass; timing may influence effectiveness, though the “anabolic window” is less critical than once thought.
- ✓ It is advised to engage in **daily exercise** and **tailor protein intake to individual needs**, within a range of 1-1.5 g/kg body weight/day.



This training material has been reviewed for scientific accuracy and relevance by Stuart Phillips – McMaster Experts. It is intended for educational purposes only and does not replace clinical judgment or institutional guidelines.



Stuart Phillips

Professor in the department of kinesiology at **McMaster University**

- Tier 1 Canada research chair in skeletal muscle health
- **Director** of the physical activity center of excellence (**PACE**) and the Mc Master center for nutrition, exercise and health research
- Leads the exercise metabolism research group.
- His academic work primarily investigates how **nutrition** and **physical activity** influence skeletal muscle in humans.

Thank you!

