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Review

The Link Between Exercise and Diminishing Body Metabolism: How Pre/Probiotics Help Maintain a Healthy Aging Process

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Abstract

Declining whole-body and skeletal muscle protein metabolism is frequently linked to ageing, which can lead to metabolic diseases, sarcopenia, and decreased muscle mass. Slower metabolic processes and a higher risk of chronic diseases result from this reduction. Through increased muscle protein synthesis and improved inter-organ metabolic coordination, aerobic exercise has been demonstrated to partially counteract these effects. Prebiotics and probiotics have been shown to modulate the gut microbiota, which in turn affects systemic inflammation, nutrient absorption, and overall metabolic health. This article explores the ways in which gut microbiome-targeting therapies, such pre/probiotics, and exercise can complement one another to maintain metabolic function and encourage better ageing.

Keywords: prebiotics; probiotics; nutrients; exercise

1. Introduction

Maintaining health and functionality into old age has become a crucial public health objective as the world's population ages. The progressive slowdown of metabolic activities, particularly as a result of decreased protein turnover and muscle atrophy, is one of the main physiological problems associated with ageing. This deterioration is associated with sarcopenia, increased fat buildup, insulin resistance, and a lower quality of life. It is crucial to comprehend actions that can postpone or undo these effects. Two evidence-based tactics are covered in this paper: Frequent aerobic exercise combined with probiotics and prebiotics to modify the gut microbiome [1–3].

2. The Impact of Aging on Body Metabolism [4–9]

2.1. Muscle Protein Metabolism and Sarcopenia

- **Decline in Protein Synthesis:** Aging is marked by a reduction in muscle protein synthesis rates, which directly contributes to loss of lean muscle mass.
- **Sarcopenia Development:** This condition involves not just muscle mass loss but also functional decline, leading to mobility issues and frailty.
- **Metabolic Slowdown:** With less muscle mass, basal metabolic rate (BMR) decreases, further complicating weight and energy regulation.

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2.2. Insulin Resistance and Fat Accumulation

- **Increased Visceral Fat:** Older adults tend to accumulate fat around the abdomen, which is strongly associated with metabolic dysfunction.
- **Reduced Insulin Sensitivity:** Aging is often accompanied by impaired glucose metabolism, increasing the risk of type 2 diabetes.

3. Exercise as a Strategy to Combat Metabolic Decline [10–14]

3.1. Effects on Muscle Protein Synthesis

- **Enhanced Turnover:** Exercise stimulates both protein synthesis and breakdown, promoting muscle repair and growth even in older adults.
- **Resistance Training vs. Aerobic Exercise:** While resistance training boosts muscle mass, aerobic exercise improves mitochondrial function and endurance.

3.2. Systemic Metabolic Integration

- **Improved Organ Crosstalk:** Exercise enhances coordination between skeletal muscle, liver, and adipose tissue, regulating energy metabolism.
- **Mitochondrial Health:** Physical activity increases mitochondrial density and function, reducing oxidative stress and improving energy production.

3.3. Functional and Clinical Benefits

- **Improved Insulin Sensitivity:** Exercise helps regulate blood sugar and enhances insulin action.
- **Lower Inflammatory Markers:** Physical activity reduces systemic inflammation, a key component of aging-related disease.

4. Gut Microbiota: A New Frontier in Healthy Aging [15–17]

4.1. Role of the Gut Microbiome

- **Microbiota and Metabolism:** The gut microbiome influences nutrient absorption, immune function, and energy balance.
- **Inflammaging:** An imbalanced microbiota contributes to chronic, low-grade inflammation seen in aging.

4.2. Benefits of Prebiotics and Probiotics

- **Prebiotics:** Non-digestible fibers that stimulate the growth of beneficial gut bacteria (e.g., inulin, fructooligosaccharides).
- **Probiotics:** Live microorganisms (e.g., *Lactobacillus*, *Bifidobacterium*) that confer health benefits when consumed in adequate amounts.

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4.3. Effects on Muscle and Metabolic Health

- **Reduced Inflammation:** Probiotics may lower levels of inflammatory cytokines, improving tissue function.
- **Enhanced Nutrient Absorption:** Pre/probiotics improve absorption of amino acids and micronutrients, supporting muscle health.
- **Potential for Sarcopenia Prevention:** Improved gut health is increasingly linked to better muscle mass and strength in older adults.

5. Synergistic Role of Exercise and Gut Health in Aging [18–20]

Combining exercise with gut-targeting strategies may yield amplified benefits. While exercise directly supports muscle and metabolic function, probiotics and prebiotics offer indirect support by enhancing the internal environment—especially nutrient availability and immune balance.

Table 1. Comparison of the Effects of Exercise and Pre/Probiotics on Aging-Related Metabolic Health.

Parameter	Exercise	Prebiotics/Probiotics
Muscle Protein Synthesis	Stimulates synthesis and turnover	Indirect support via nutrient absorption
Mitochondrial Function	Increases density and efficiency	Limited direct effect
Insulin Sensitivity	Improves glucose uptake	May improve through reduced inflammation
Inflammation	Reduces systemic inflammation	Modulates gut-derived inflammation (inflammaging)
Gut Microbiota Balance	Mild positive effects	Strong modulatory effects
Sarcopenia Risk	Decreased with regular training	May be reduced through improved nutrient and gut health
Fat Distribution	Reduces central/visceral adiposity	Limited direct effect

6. Conclusions

A decrease in metabolic efficiency is closely associated with ageing, particularly because of elevated inflammation and decreased muscle protein turnover. For older persons, aerobic and resistance exercise continue to be essential therapies for maintaining muscle and metabolic health. At the same time, there is mounting evidence that the effects of employing probiotics and prebiotics to modify the gut microbiota are complimentary. These include better metabolic control, less systemic inflammation, and enhanced nutrition absorption. Exercise and gut health support are two lifestyle-based therapies that work in concert to promote healthy ageing. To increase healthspan and lessen the burden of aging-related disorders, public health initiatives and individual health plans should think about combining the two.

References

1. Munot N, Kandekar U, Rikame C, Patil A, Sengupta P, Urooj S, et al. Improved mucoadhesion, permeation and in vitro anticancer potential of synthesized thiolated acacia and karaya gum combination: a systematic study. Molecules. 2022;27:6829.
2. Munot N, Kandekar U, Giram PS, Khot K, Patil A, Cavalu S. A comparative study of quercetin-loaded nanocochleates and liposomes: formulation, characterization, assessment of degradation and in vitro anticancer potential. Pharmaceutics. 2022;14:1601.
3. Manikyam HK, Tripathi P, Patil SB, Lamichhane J, Chaitanya M, Patil AR. Extraction, purification, and quantification of hesperidin from the immature Citrus grandis/maxima fruit Nepal cultivar. Asian J Nat Prod Biochem. 2022;20.
4. Patil A, Munot N, Patwekar M, Patwekar F, Ahmad I, Alraey Y, et al. Encapsulation of lactic acid bacteria by lyophilisation with its effects on viability and adhesion properties. Evid Based Complement Alternat Med. 2022;2022:1–9.

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5. Nalawade AS, Gurav RV, Patil AR, Patwekar M, Patwekar F. A comprehensive review on morphological, genetic and phytochemical diversity, breeding and bioprospecting studies of genus Chlorophytum Ker Gawl. from India. Trends Phytochem Res. 2022;6(1):19–45.
6. Patil KG, Balkundhi S, Joshi H, Ghewade G. Mehsana buffalo milk as prebiotics for growth of Lactobacillus. Int J Pharm Pharm Res. 2011;1(1):114–7.
7. Das N, Ray N, Patil AR, Saini SS, Waghmode B, Ghosh C, et al. Inhibitory effect of selected Indian honey on colon cancer cell growth by inducing apoptosis and targeting the β-catenin/Wnt pathway. Food Funct. 2022;13:8283–303.
8. Patil MJ, Mali V. The diverse cytotoxicity evaluation of Lactobacillus discovered from sheep milk. Acta Sci Pharm Sci. 2021;5(12):69–70.
9. Abhinandan P, John D. Probiotic potential of Lactobacillus plantarum with the cell adhesion properties. J Glob Pharma Technol. 2020;10(12):1–6.
10. Patil A, Pawar S, Disouza J. Granules of unistrain Lactobacillus as nutraceutical antioxidant agent. Int J Pharm Sci Res. 2018;9(4):1594–9.
11. Patil A, Mali V, Patil R. Banana fibers camouflaging as a gut worm in a 6-month-old infant. Iberoam J Med. 2020;2:245–7.
12. Munot NM, Shinde YD, Shah P, Patil A, Patil SB, Bhinge SD. Formulation and evaluation of chitosan-PLGA biocomposite scaffolds incorporated with quercetin liposomes made by QbD approach for improved healing of oral lesions. AAPS PharmSciTech. 2021;24(6):147.
13. Patil A. Psychology in the age of technology dependence and the mobile dilemma. Preprints.org. 2023;2023070101.
14. Patil A, Kotekar D, Chavan G. Knowing the mechanisms: how probiotics affect the development and progression of cancer. Preprints.org. 2023;2023070243.
15. Kim CS, Jung MH, Shin DM. Probiotic supplementation has sex-dependent effects on immune responses in association with the gut microbiota in community-dwelling older adults: a randomized, double-blind, placebo-controlled, multicenter trial. Nutr Res Pract. 2023;17(5):883–898.
16. Li G, Li W, Song B, et al. Differences in the gut microbiome of women with and without hypoactive sexual desire disorder: a case-control study. J Med Internet Res. 2021;23(2):e25342.
17. Rahmani S, Keshavarz SA, Hosseini S. Adjuvant administration of probiotic effects on sexual function in patients with major depressive disorder: a randomized, double-blind, placebo-controlled trial. BMC Psychiatry. 2023;23:429.
18. Basnet J, Eissa MA, Yanes Cardozo LL, Romero DG, Rezq S. Impact of probiotics and prebiotics on gut microbiome and hormonal regulation. Gastrointest Disord. 2024;6(4):801–815.
19. Pernigoni N, Zagato E, Calcinotto A, et al. Commensal bacteria promote endocrine resistance in prostate cancer through androgen biosynthesis. Science. 2021;374(6564):216–224.
20. Kim CS, Cha L, Sim M, et al. Probiotic supplementation improves cognitive function and mood with changes in gut microbiota in community-dwelling older adults: a randomized, double-blind, placebo-controlled, multicenter trial. J Gerontol A Biol Sci Med Sci. 2021;76(1):32–40.

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