Nutritional Support in Pulmonary Diseases

Module 38.3
Nutritional Modulation of Metabolism in COPD; Similarities with Top Sports?

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Learning Objectives

- To learn about the energy cost of exercise and the use of carbohydrate and fat as substrates;
- To learn about the need for carbohydrate to sustain moderate-to-high intensity exercise;
- To learn about the role of dietary protein to support post-exercise recovery;
- To learn about the impact of dietary protein to support muscle reconditioning;
- To learn about the use of ergogenic aids to improve exercise performance;
- To learn about the capacity of dietary nitrate to reduce oxygen requirements during exercise.

Contents

1. Introduction
2. Skeletal muscle substrate selection during exercise
3. Muscle reconditioning following exercise
4. Ergogenic aids
5. Summary
6. References

Key Messages

- Endogenous carbohydrate stores should be sufficient to allow moderate-to-high intensity exercise;
- Dietary protein intake following exercise is required to maximize post-exercise recovery;
- Dietary protein intake is required to optimize skeletal muscle conditioning;
- Ingestion of 20-25 g protein is sufficient to increase post-exercise muscle protein synthesis;
- Some ergogenic aids may improve performance but only in specific conditions;
- Dietary nitrate can lower oxygen requirements but has not been shown to improve performance in COPD.
1. Introduction

In addition to regular training, nutrition is one of the most important factors with which we can modulate skeletal muscle substrate use and, as such, performance capacity. A well-balanced diet, adapted to the specific demands imposed by the individual’s health and physical activity pattern and/or exercise, can truly improve performance capacity. An optimal dietary regimen does not guarantee a winning performance, but without proper nutrition optimal performance will be impossible.

2. Skeletal Muscle Substrate Selection During Exercise

Carbohydrate and fat are the two primary fuel sources oxidized by skeletal muscle tissue during exercise. The relative contribution of these fuel sources largely depends on the exercise intensity and duration, with a greater contribution from carbohydrate as exercise intensity is increased. Consequently, prolonged endurance performance or endurance capacity are often dictated by endogenous carbohydrate availability. As such, improving carbohydrate availability during prolonged exercise through carbohydrate ingestion has dominated the field of sports nutrition research. As a result, it has been well-established that carbohydrate ingestion during prolonged (>2 h) moderate-to-high intensity exercise can significantly improve endurance performance (1). For exercise lasting 1 to 2.5 hours, athletes are advised to ingest 30-60 g of carbohydrates per hour. Well-trained endurance athletes competing for longer than 2.5 hours at high intensity can metabolise up to 90 g of carbohydrates per hour, provided that a mixture of glucose and fructose is ingested. For sedentary people starting a physical activity program and/or for patients starting up a rehabilitative exercise training program carbohydrate ingestion during exercise will not be required as endogenous carbohydrate availability will be unlikely to be limiting. However, an increased dependence on carbohydrate use in deconditioned COPD patients may provide a rationale for (some) carbohydrate intake prior to or during exercise in these patients.

3. Muscle Reconditioning Following Exercise

Dietary protein ingestion after exercise stimulates muscle protein synthesis, inhibits protein breakdown and, as such, stimulates net muscle protein accretion following resistance as well as endurance type exercise. Protein ingestion during and/or immediately after exercise has been suggested to facilitate the skeletal muscle adaptive response to each exercise session, resulting in more effective muscle reconditioning (2, 3). A few basic guidelines can be defined with regard to the preferred type and amount of dietary protein and the timing at which protein should be ingested. Whey protein seems to be most effective to increase post-exercise muscle protein synthesis rates. This is likely to be attributable to its rapid digestion and absorption kinetics and relatively high leucine content. Ingestion of approximately 20 g of a high quality protein during and/or immediately after exercise is sufficient to maximize post-exercise muscle protein synthesis rates. Additional ingestion of large amounts of carbohydrate does not further increase post-exercise muscle protein synthesis rates when ample protein is already ingested. Dietary protein should be ingested immediately after cessation of exercise to allow muscle protein synthesis rates to reach maximal levels.
Dietary protein supplementation represents an effective dietary strategy to augment the adaptive response of skeletal muscle to prolonged resistance-type exercise training in healthy adults as well as in clinically compromised patient groups. Sufficient dietary protein and appropriate timing of protein intake and dietary protein intake distribution throughout the day are likely key factors that can optimize muscle reconditioning in response to rehabilitative resistance type exercise training. The synergy between exercise and protein intake should be given attention when implementing exercise training in compromised patients such as those with COPD.

4. Ergogenic Aids

Although a healthy, well balanced diet forms the foundation of any nutritional plan to support muscle reconditioning, there may be nutritional compounds that could help to enhance the muscle adaptive response in the active older adult. Oral supplementation with creatine has been a long-standing, evidenced-based strategy employed by recreational and competitive athletes as an ergogenic aid for high-intensity (repetitive) exercise performance, and to augment training adaptations in young resistance type athletes. Creatine is generally consumed in relatively large doses (eg 20 g per day) for 5–7 days in order to ‘load’ the muscle, with a maintenance dose of 2–5 g per day thereafter to maintain elevated muscle creatine levels for several weeks. Ergogenic benefits are attributed to an increased muscle store of phosphocreatine, allowing improved adenosine triphosphate delivery from phosphocreatine hydrolysis during high-intensity exercise, allowing for a greater training stimulus and, ultimately, an augmented training adaptation. Although most studies have been conducted in young athletes, a recent meta-analysis concluded that the addition of oral creatine supplementation to regular exercise training in older adults also allows for greater gains in muscle mass and strength. Conflicting results are however reported from dietary creatine supplementation in patients with COPD (4).

Another nutritional approach that has received much attention is use of fish oil-derived omega-3 fatty acids (5). It has been reported that prolonged omega-3 supplementation results in a greater muscle protein synthetic response to amino acid administration. Furthermore, it has been proposed that more prolonged fish oil supplementation improves physical performance indices such as walking speed. Moreover, consumption of fish oil supplements has been reported to result in greater gains in muscle strength and functional capacity following prolonged resistance type exercise training when compared with a placebo. Other nutritional compounds of potential value include vitamin D and dietary nitrate.

Nutritional strategies can be applied as ergogenic aids to enhance performance, but may also target specific muscle pathology in COPD including muscle wasting and altered regulation of muscle oxidative metabolism. Despite the rationale for protein (6), specific amino acids, fish oil (5), dietary nitrate (7) and/or vitamin D (8) supplementation to improve performance or facilitate exercise training induced muscle reconditioning, remarkably few studies have explored the impact of such nutritional intervention strategies on exercise performance or the adaptive response to exercise training in COPD (9).
5. Summary

Long-term intervention studies have demonstrated benefits from dietary protein supplementation to further augment gains in muscle mass and strength during prolonged resistance-type exercise training. Emerging evidence also suggests that creatine, dietary nitrate, vitamin D and/or fish oil-derived fatty acid supplementation may be effective as means to further enhance exercise training adaptations. Future work will provide the mechanistic insights into the synergy between exercise training and nutritional interventions to help us define interventional strategies that maximize gains in muscle mass, strength and function during prolonged exercise training.

6. References