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Effects of protein in combination with carbohydrate supplements on acute or repeat endurance exercise performance: a systematic review.

McLellan TM[1], Pasiakos SM, Lieberman HR.

Author information

Abstract

BACKGROUND: Protein supplements are consumed frequently by **athletes** and recreationally active adults for various reasons, including improved exercise performance and recovery after exercise. Yet, far too often, the decision to purchase and consume **protein** supplements is based on marketing claims rather than available evidence-based research.

OBJECTIVE: The purpose of this **review** was to provide a systematic and comprehensive analysis of the literature that tested the hypothesis that **protein** supplements, when combined with carbohydrate, directly enhance endurance performance by sparing muscle glycogen during exercise and increasing the rate of glycogen restoration during recovery. The analysis was used to create evidence statements based on an accepted strength of recommendation taxonomy.

DATA SOURCES: English language articles were searched with PubMed and Google Scholar using **protein** and supplements together with performance, exercise, competition, and muscle, alone or in combination as keywords. Additional articles were retrieved from reference lists found in these papers.

STUDY SELECTION: Inclusion criteria specified recruiting healthy active adults less than 50 years of age and evaluating the effects of **protein** supplements in combination with carbohydrate on endurance performance metrics such as time-to-exhaustion, time-trial, or total power output during sprint intervals. The literature search identified 28 articles, of which 26 incorporated test metrics that permitted exclusive categorization into one of the following sections: ingestion during an acute bout of exercise (n = 11) and ingestion during and after exercise to affect subsequent endurance performance (n = 15). The remaining two articles contained performance metrics that spanned both categories.

STUDY APPRAISAL AND SYNTHESIS METHODS: All papers were read in detail and searched for experimental design confounders such as energy content of the supplements, dietary control, use of trained or untrained participants, number of subjects recruited, direct measures of muscle glycogen utilization and restoration, and the sensitivity of the test metrics to explain the discrepant findings.

RESULTS: Our evidence statements assert that when carbohydrate supplementation was delivered at optimal rates during or after exercise, **protein** supplements provided no further ergogenic effect, regardless of the performance metric used. In addition, the limited data available

suggested recovery of muscle glycogen stores together with subsequent rate of utilization during exercise is not related to the potential ergogenic effect of **protein** supplements.

LIMITATIONS: Many studies lacked ability to measure direct effects of **protein** supplementation on muscle metabolism through determination of muscle glycogen, kinetic assessments of **protein** turnover, or changes in key signaling **proteins**, and therefore could not substantiate changes in rates of synthesis or degradation of **protein**. As a result, the interpretation of their data was often biased and inconclusive since they lacked ability to test the proposed underlying mechanism of action.

CONCLUSIONS: When carbohydrate is delivered at optimal rates during or after endurance exercise, **protein** supplements appear to have no direct endurance performance enhancing effect.

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