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Impact of Pre-Exercise Macronutrient Intake on Strength and Endurance Performance in Male Athletes

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Abstract

This study examined the impact of pre-exercise macronutrient intake on strength and endurance performance in male athletes. A total of sixty male university athletes (aged 18–25 years) were randomly assigned to three dietary groups: carbohydrate-rich, protein-rich, and mixed macronutrient intake. Participants consumed their assigned meals 90 minutes prior to exercise testing. Strength performance was evaluated using one-repetition maximum (1RM) tests for bench press and leg press, while endurance performance was measured through a 5-kilometer treadmill run. The intervention lasted for six weeks, with pre-test and post-test assessments conducted for all variables. Statistical analysis using ANOVA revealed significant differences among groups ($p < 0.05$). The carbohydrate-rich and mixed macronutrient groups showed notable improvements in endurance performance, whereas the protein-rich group demonstrated slightly greater gains in strength measures. These findings suggest that pre-exercise meal composition plays a crucial role in optimizing physical performance. Tailoring macronutrient intake according to exercise type may enhance both strength and endurance outcomes in male athletes.

Keywords: Pre-exercise nutrition, Macronutrients, Strength, Endurance, Male athletes

Introduction

Proper nutrition is a critical factor influencing athletic performance and overall physical capacity. Pre-exercise meals are particularly important as they provide essential energy substrates and regulate metabolic responses that directly affect both strength and endurance outcomes (Kerksick et al., 2018). Macronutrients—carbohydrates, proteins, and fats—play distinct and complementary roles in exercise metabolism. Carbohydrates are widely recognized as the primary energy source for moderate to high-intensity endurance activities, as they help maintain blood glucose levels and delay fatigue (Burke et al., 2017; Jeukendrup, 2019). In contrast, protein intake is essential for muscle repair, recovery, and adaptation, especially in resistance-based activities (Tipton & Wolfe, 2018). Although fats contribute to long-duration, low-intensity exercise, their role in immediate pre-exercise nutrition remains less significant (Spriet, 2014).

Previous research has produced mixed findings regarding the optimal timing and composition of pre-exercise macronutrient intake, with some studies highlighting enhanced performance following carbohydrate-rich meals, while others suggest benefits of combined or protein-focused intake (Kerksick et al., 2018; Thomas et al., 2016). Additionally, individual variability, training status, and type of sport may influence these outcomes. Therefore, further investigation is needed to clarify the role of pre-exercise macronutrient strategies. This study aims to examine the impact of pre-exercise macronutrient intake on strength and endurance performance in male athletes, providing evidence-based recommendations for athletes, coaches, and sports nutrition practitioners.

Methodology

Study Design

This study employed a randomized controlled trial design to investigate the effects of pre-exercise macronutrient intake on strength and endurance performance in male athletes. Participants were randomly allocated into three experimental groups to ensure unbiased distribution and to enhance the internal validity of the study. The intervention period lasted for six weeks, during which all participants followed their assigned dietary protocols prior to performance testing sessions.

Participants

A total of 60 male university athletes, aged between 18 and 25 years, were recruited using purposive sampling techniques. All participants were actively engaged in regular resistance and endurance training programs for at least six months prior to the study. Inclusion criteria required participants to be free from chronic diseases, metabolic disorders, and recent musculoskeletal injuries that could affect performance outcomes. Prior to participation, all subjects provided informed consent, and ethical approval was obtained from the relevant institutional review board.

Group Allocation and Dietary Intervention

Participants were randomly divided into three equal groups (n = 20 per group) based on pre-exercise macronutrient intake. The first group consumed a carbohydrate-rich meal consisting of 70% carbohydrates, 15% protein, and 15% fat. The second group was assigned a protein-rich meal comprising 50% protein, 30% carbohydrates, and 20% fat. The third group received a mixed macronutrient meal containing 40% carbohydrates, 30% protein, and 30% fat. All meals were standardized in terms of total caloric content and were consumed 90 minutes prior to exercise testing to ensure adequate digestion and nutrient availability.

Testing Procedures

Performance assessments were conducted at baseline (pre-test) and after the six-week intervention period (post-test). Strength performance was measured using one-repetition maximum (1RM) tests for the bench press and leg press exercises, following standardized testing protocols to ensure reliability and safety. Endurance performance was evaluated using a 5-kilometer treadmill run, where completion time was recorded in minutes. All testing sessions were conducted under controlled environmental conditions, and participants were instructed to maintain consistent training routines and avoid additional supplementation throughout the study period.

Statistical Analysis

Data were analyzed using statistical software. Descriptive statistics, including mean and standard deviation (Mean ± SD), were calculated for all variables. A one-way analysis of variance (ANOVA) was performed to determine significant differences among the three groups. Where significant differences were observed, post hoc tests were applied to identify specific group differences. The level of significance was set at $p < 0.05$ for all statistical analyses.

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Table 1: *Strength Performance (1RM Bench Press and Leg Press)*

Group	Bench Press 1RM (kg) Pre	Bench Press 1RM (kg) Post	Leg Press 1RM (kg) Pre	Leg Press 1RM (kg) Post
Carbohydrate-rich	80 ± 10	85 ± 11	150 ± 20	158 ± 18
Protein-rich	82 ± 9	88 ± 10	152 ± 18	160 ± 19
Mixed macronutrient	81 ± 11	86 ± 12	151 ± 19	159 ± 20

Table 2: *Endurance Performance (5 km Run Time in minutes)*

Group	Pre-Test	Post-Test
Carbohydrate-rich	24.5 ± 1.5	22.8 ± 1.2
Protein-rich	24.7 ± 1.4	24.0 ± 1.3
Mixed macronutrient	24.6 ± 1.6	23.0 ± 1.2

Results

The results presented in **Table 1** demonstrate changes in strength performance, measured through one-repetition maximum (1RM) in bench press and leg press, across the three dietary groups. All groups showed improvements from pre-test to post-test, indicating that training combined with pre-exercise nutrition positively influenced strength outcomes. The carbohydrate-rich group improved from 80 ± 10 kg to 85 ± 11 kg in bench press and from 150 ± 20 kg to 158 ± 18 kg in leg press. The protein-rich group exhibited the greatest gains in strength, increasing from 82 ± 9 kg to 88 ± 10 kg in bench press and from 152 ± 18 kg to 160 ± 19 kg in leg press. Similarly, the mixed macronutrient group showed moderate improvements, with bench press increasing from 81 ± 11 kg to 86 ± 12 kg and leg press from 151 ± 19 kg to 159 ± 20 kg. Overall, while all groups improved, the protein-rich group demonstrated slightly superior strength enhancements.

Table 2 presents the endurance performance results based on 5 km run time. A decrease in run time indicates improved endurance. The carbohydrate-rich group showed the most significant improvement, reducing their time from 24.5 ± 1.5 minutes to 22.8 ± 1.2 minutes. The mixed macronutrient group also demonstrated notable improvement, decreasing from 24.6 ± 1.6 minutes to 23.0 ± 1.2 minutes. In contrast, the protein-rich group showed only a slight improvement, with run time decreasing from 24.7 ± 1.4 minutes to 24.0 ± 1.3 minutes. These findings suggest that carbohydrate-rich and mixed macronutrient intake is more effective in enhancing endurance performance,

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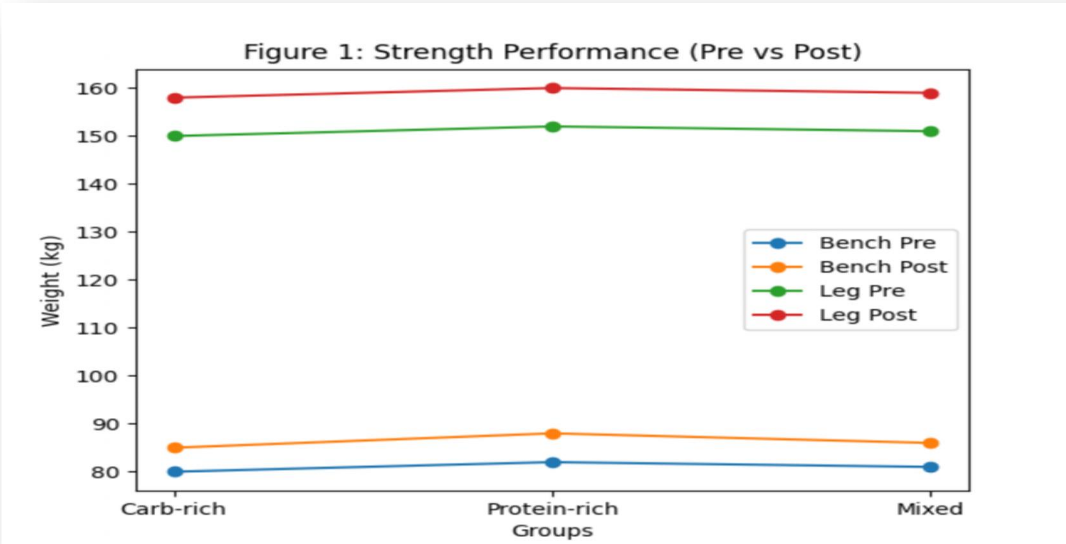
while protein-rich intake has a comparatively smaller effect on endurance.



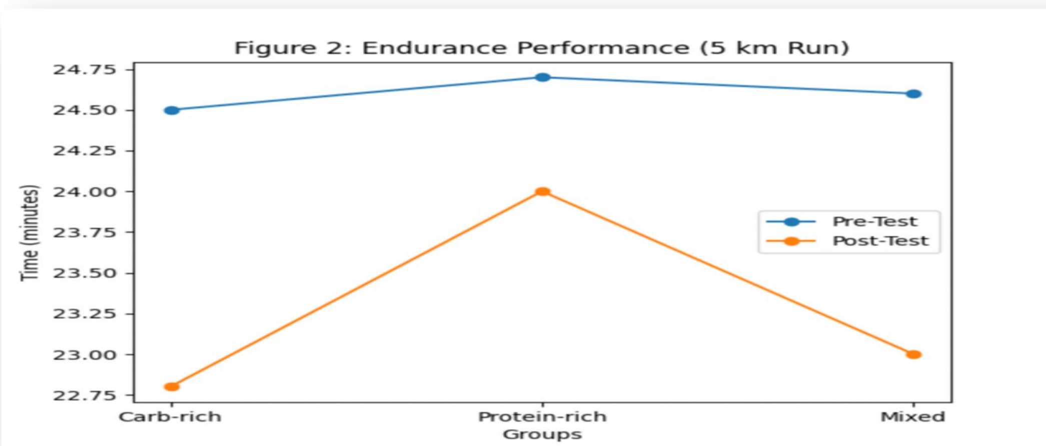


Figure 1 illustrates the comparison of pre-test and post-test strength performance, measured through one-repetition maximum (1RM) bench press and leg press, among the three groups: carbohydrate-rich, protein-rich, and mixed macronutrient intake. All groups demonstrated improvements in strength after the six-week intervention period, indicating the positive effect of training combined with pre-exercise nutrition. The protein-rich group showed the greatest increase in both bench press and leg press values, suggesting that higher protein intake before exercise may support muscle

strength development. The mixed macronutrient group also showed considerable improvements, while the carbohydrate-rich group exhibited relatively moderate gains in strength performance.

Figure 2 presents the changes in endurance performance based on 5 km run time across the same groups. A reduction in run time reflects improved endurance capacity. The carbohydrate-rich group showed the most significant decrease in completion time, indicating superior enhancement in endurance performance. The mixed macronutrient group also demonstrated notable improvement, whereas the protein-rich group showed only slight changes. These results suggest that carbohydrate intake before exercise plays a more crucial role in improving endurance performance compared to protein-focused meals.

Discussion

The present study examined the impact of pre-exercise macronutrient intake on strength and endurance performance in male athletes. The findings from Figure 1 indicate that all groups experienced improvements in strength performance following the six-week intervention; however, the protein-rich group demonstrated the greatest gains in both bench press and leg press measures. This finding aligns with previous research suggesting that protein intake before exercise enhances muscle protein synthesis and supports strength development (Tipton & Wolfe, 2018). The mixed macronutrient group also showed considerable improvements, likely due to the combined availability of carbohydrates for energy and protein for muscle repair. In contrast, the carbohydrate-rich group showed relatively smaller improvements in strength, highlighting that carbohydrates alone may not be sufficient to maximize strength adaptations.

Figure 2 highlights the changes in endurance performance, where the carbohydrate-rich group showed the most significant improvement in 5 km run time, followed by the mixed macronutrient group. These findings are consistent with established evidence that carbohydrates serve as the primary fuel source during prolonged and moderate-to-high intensity exercise, helping to maintain glycogen stores and delay fatigue (Burke et al., 2017; Jeukendrup, 2019). The protein-rich group demonstrated only minimal improvements in endurance, suggesting that protein alone does not provide adequate immediate energy for endurance activities.

Overall, the results of this study emphasize the importance of tailoring pre-exercise nutrition according to the type of physical activity. For strength-focused performance, protein-rich meals appear to be more beneficial, whereas carbohydrate-rich meals are more effective for endurance enhancement. The mixed macronutrient approach offers a balanced benefit, making it suitable for sports requiring both strength and endurance. These findings are also supported by broader sports nutrition guidelines, which recommend individualized nutrition strategies based on training demands and performance goals (Thomas et al., 2016; Kerksick et al., 2018).

Conclusion

The findings of this study indicate that pre-exercise macronutrient intake plays a crucial role in optimizing athletic performance in male athletes. Specifically, protein-rich meals consumed prior to training sessions produced the greatest improvements in strength measures, as observed in bench press and leg press performance. In contrast, carbohydrate-rich meals resulted in the most significant enhancement of endurance performance, demonstrated by reduced 5 km run times. The mixed macronutrient approach, which combines carbohydrates and protein, offered balanced improvements in both strength and endurance, suggesting its suitability for athletes whose training requires a combination of these performance attributes.

These results emphasize the importance of individualized nutrition strategies tailored to the type of exercise or sport-specific demands. Athletes focused on resistance training may benefit from protein-focused pre-exercise meals, while those engaged in endurance-based activities should prioritize carbohydrate intake for optimal energy availability. Incorporating a balanced macronutrient meal can provide a versatile approach for mixed training programs. Overall, pre-exercise meal composition should be considered a key component of training planning, providing a practical and evidence-based method to enhance performance, improve training outcomes, and reduce fatigue.

Recommendations

Based on the findings of this study, several practical recommendations can be made to optimize athletic performance through pre-exercise nutrition:

1. **Strength-focused athletes** should prioritize protein-rich meals before training or competition, as protein intake supports muscle protein synthesis, enhances strength development, and aids in recovery (Tipton & Wolfe, 2018).
2. **Endurance athletes** should consume carbohydrate-rich meals prior to exercise to maintain glycogen stores, delay fatigue, and improve endurance performance (Burke et al., 2017; Jeukendrup, 2019).
3. **Athletes involved in combined training or sports requiring both strength and endurance** may benefit from a mixed macronutrient meal containing both carbohydrates and protein. This approach offers balanced energy availability and supports both muscle performance and endurance capacity.

4. **Timing of intake** is critical: pre-exercise meals should ideally be consumed 60–90 minutes before activity to allow sufficient digestion and nutrient absorption.
5. **Individualization**: Coaches and sports nutritionists should tailor pre-exercise nutrition plans according to the athlete's sport, training load, body composition, and personal tolerance to specific foods.
6. **Further research** should explore optimal portion sizes, macronutrient ratios, and the impact of hydration strategies in conjunction with pre-exercise meals to maximize performance outcomes.

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