GUMAN
گمان
VOL 7, ISSUE 3, 2024
E(ISSN) 2709-4162, P(ISSN) 2709-4154
https://guman.com.pk/index.php/GUMAN

# Nutritional Interventions and Their Effects on Athletic Performance and Recovery

**Najiah**
MS scholar Sarhad University of Science and Information Technology, Peshawar at najshahab1@gmail.com

**Rasool Jaan**
Online Fitness Coach International Sports Science Association (ISSA) USA at- Jaanli2006@gmail.com

**Dr. Khalid Usman**
Assistant Professor Health and Physical Education in Higher Education Department at GDC Sabir Abad Karak at- khalidusman1979@gmail.com

**Muhammad Iftikhar khan**
Lecturer, Department of Sports Sciences and Physical Education, SUIT Peshawar, KP, Pakistan at- ifti8594352@gmail.com

SCAN ME

## Abstract

*Nutrition plays an important role not only in athletic performance but also in the recovery period. In terms of micronutrients, macronutrient intake and hydration and dietary supplements enhance both performance and recovery among athletes. Adequate nutrition influence muscles work, higher energy endurance and muscle strength besides supporting the recovery period after the exercise. The purpose of this research is to investigate the impact for various nutritional modifications in sports enthusiasts for carbohydrates and protein consumption, hydration, and supplementation on the martial arts' performance and recovery, as well as other sporting activities. A randomized controlled trial (RCT) was conducted with 60 athletes from diverse sports, assigned to four intervention groups: carbohydrate loading, protein intake, proper fluid intake, and dietary supplementations including creatine, beta- alanine and branch chain amino acids. All the endurance, strength and recovery assessments such as time-to-exhaustion, one-repetition maximum (1RM) and blood lactate clearance were measured at baseline, halfway through the intervention and at the end. To evaluate the effectiveness of each intervention, data that were collected were also subjected to repeated measures ANOVA. Improvements were recorded in all the groups; however, the high carbohydrate group recorded the most pronounced improvement in*

GUMAN
گمان
VOL 7, ISSUE 3, 2024
E(ISSN) 2709-4162, P(ISSN) 2709-4154
https://guman.com.pk/index.php/GUMAN

*endurance performance with time to exhaustion improving by 8. 2%.The high-protein group lifts significantly their strength by 9. 5% in 1RM squat whereas the supplementation group recorded the greatest enhancement in strength, power and recovery facets up to 12. 5% in 1RM bench press and muscle soreness decrease by 4. 2 points. These findings indicate that specific modifications in the diet in the form of carbohydrates for endurance runners and protein/creatine monohydrate for strength performers, can increase performance. Positive effects of hydration also became significant for endurance though their effects on the strength parameters were slightly smaller. The aids like creatine and beta-alanine are said to have shown significant results in enhancing strength, power and recovery. Proper nutrition really counts in an athlete's abilities and even the time he takes to recuperate from an exercise. The best results can be achieved when nutritional strategies used are in line with sport and the athlete's individual physiological adaptations. These findings make it beneficial for athletes and coaches to positively adopt sound progressive meal's plan to enhance performance plus recovery time.*

***Keywords-*** *Nutritional Interventions and Their Effects on Athletic Performance and Recovery*

**Introduction**

Health and fitness and the other is the ability to recuperate after use. These are major factors that define success in competitive sporting disciplines and they are largely dictated by nutrition. A number of studies in the recent literature on sports nutrition have gone beyond the topic of performance nutrition and performance nutrition in its mitigating and recovery timeframe factors including, protecting against injury, speeding up recovery and increasing health benefits (Burke & Deakin, 2015). Nutrition is important so that the right nutrients and energy sources which help the muscles, stamina, strength, and muscles' ability to recuperate is achieved.

Endurance focused athletes who have carefully planned and sport and body physique specific diets are able to produce maximal effort output and fatigue free performances, and also recover faster from tiredness and other forms of exhaustion (Hawley et al. , 2018). Based on the components where the nutrition support may be provided for patients, it is possible to separate

them into three categories: macronutrient content, hydration management, and supplements. Every of these components has a specific importance in the processes of performance increase and fatigue reduction.

For instance, carbohydrates become the major source of nutrients for such athletes especially because they are easily converted to energy in exercises that require high energy endurance. Consumption of carbohydrates before, during, and after exercise has been observed to enhance endurance performance by replenishing glycogens and extending it in the energy system besides providing a fast energy source during the exercise (Thomas et al. , 2016). Conversely, proteins play important roles of muscle repair and growth in the human body. It has been shown that during the post exercise time if protein is consumed it goes to the muscle and helps in building the muscles and reduces the damage it incurs during the exercise thereby aiding in the recovery process (Tipton & Wolfe, 2004). While fats are usually underrated, they are a valuable source of energy during exercise performed at low intensity but for a long period and are also involved in hormone synthesis and nutrient transport (Jeukendrup & Gleeson, 2018).

However, water and electrolyte are above macronutrient as critical determinants of performance and recovery time. Dehydration reduces an athlete's ability to regulate his or her body's temperature, decreases blood volume, and increases perception of fatigue (Casa et al. , 2000). Sodium and potassium are essential for proper hydration and muscular contractions; their deficits/disturbances can cause dehydration/Cramps esp. during endurance activities (Sawka et al. , 2007). Supplements have also been taken on a large scale with special interest to athletes who wish to improve on their performance. Of all the supplements, the most researched supplement that has been proved to enhance performance in the short maximized workouts such as weight training and sprinting through the boost of ATP (adenosine triphosphate) is creatine (Kreider et al. , 2017).

Likewise, beta-alanine has been identified to counter the accumulation of lactic acid, thus avoiding early onset of muscle fatigue during high intensity exercises( Hobson et al. , 2012). There are other related supplements like branched chain amino acids believed to assist in some way as holding back muscles pain and recovery but the evidence on their effectiveness is

inconclusive (Jackman et al. , 2010). It highlighted the need to extend the knowledge about the specific macronutrients and microelements' needs of athletes depending on the type of the sport, the intensity of the exercise and the individual physiological peculiarities. For instance, competitive endurance athletes and long distance runners may need relatively higher carbohydrate density due to their long-duration activity needs while strength athletes like powerlifters may benefit from higher protein and supplementations like creatine. Macronutrient content is an important factor in performance and, thus, should be provided according to the specific needs of each athlete.

Furthermore, they say that the timing of nutrient intake also determines the performance and the rate of recovery. A nutrient timing, which means that before, during and after physical activities one can consume food products that will positively influence his or her performance and subsequent recovery period (Ivy & Ferguson-Stegall, 2014). Carbohydrates during exercise may decrease glycogen loss while proteins after exercise may enhance muscle repair (Beelen et al. , 2011). However, some areas are still left unchecked and therefore more research has to be done. The chronic consequences of some supplements; the combination of various dietary approaches; and the issue of inter-individual differences in response to nutritional treatments are still debated questions (Maughan et al. , 2018). This study seeks to advance the understanding of the impact of various nutrient interventions on different types of athletes –specifically in relation to performance and recovery. This study aims at identifying and determining the factors, which relate nutrition to enhance the performance of athletes and their recovery through an examination of literature, experimental procedure and case studies in different sports.

**Literature Review**

Nutrition and its importance in improving performance of athletes and aiding their recovery has been a subject of significant interest in exercise science. Nutrition gives a description of the processes of providing the body with the energy that is required in carrying out the extended activities and also in constructing and reconstructing muscles as well as the overall wellbeing of the body. The literature shows that various aspects of nutrition are received differently in athletes and each is differently influenced depending on the type of sport and its intensity.

**Macronutrients and Athletic Performance**

Carbohydrates, proteins, and fats are the main sources of nutrients that are essential to athletes, and those nutrients depend on the energy needed to propel an athlete and the muscles' constituents acquired and used to reconstruct tissue.

**Carbohydrates and Performance** Carbohydrates are referred to as the energy supply system for athletes who engage themselves in power and or endurance sports. During the duration of the exercise, glycogen which is the compound form of carbohydrates in muscles and liver is used as a source of energy. Most of the research by Burke (2015) indicates that it is the carbohydrate stores which assist the athletes to perform better and prolong fatigue in comparison to their counterparts, who consume less carbohydrate. Reduced glycogen supply is another factor that has been predicted to impose severe constraints on athletes' performances especially during endurance activities and thus carbohydrate intake to restore glycogen concentrations is critical for performance enhancement and recovery (Kerksick et al. , 2018).

Carbohydrate distribution is also important, that is the relative times of day at which carbohydrate is consumed. Ivy and Ferguson-Stegall (2014) discuss carbohydrate utilization particularly during and right after exercising to enhance the rates of glycogen storage. This is especially so with athletes who perform consecutive training or competition without adequate rest in between. In line with this, Beelen et al. (2011) conducted a study on the effect of post exercise carbohydrate intake to performance and found out that carb specially improves recovery rates.

**Protein for Muscle Recovery** Protein is very important especially for muscle tissues in the recovery process, especially after doing high-intensity or resistance training. Muscle tissue is composed of protein and amino acids which are the subunit of protein. After exercising, particularly weight training, muscles undergo catabolism and therefore, the anabolism process commonly referred to as muscle protein synthesis has to be triggered, these can only be solved by consumption of adequate proteins (Tipton & Wolfe, 2004).

Some studies have also note that timing of protein intake is crucial, eating protein after one's exercise regime is recommended. Consumption of proteins after exercise is known to promote muscle protein synthesis, decrease muscle tenderness and shorten the muscle recovery

period (Tang, Moore, Thrush, & Rasmussen, 2007). Another aspect of what happens during the day is the timing of protein intake; the second is the quality of the proteins consumed. DP Compared to other forms of proteins like the soy, whey protein that has all the essential amino acids in it, was shown to be more potent in promoting muscle protein synthesis (Tang et al. , 2007). Due to these rapid digestion and absorption of whey protein, these are very suitable in the post workout supplementation to muscle building and recovery in athletes.

**Fats and Endurance** Fats are not always considered as important in sporting activities, but when it comes to sports performance, they are critical especially when undertaking endurance events which rely on long, low intensity activities. Fats are the main energy supply during steady-state exercises and facilitate the conservation of glycogens that are essential in energy 'explosions. ' Fat formatting or the use of a high fat-low carbohydrate diet that aims at increasing the athlete's fat turnover has also been discussed especially in the endurance events. Research has demonstrated that there is a possibility of enhancing fat as an energy substrate under exercise in fat adapted-athletes, while, in the same account there might be a reduction in performance when exercising at a high intensity because of low glycogen reserves (Volek et al. , 2015).

**Hydration and Electrolytes in Athletic Performance**

Another factor that should not be ignored when it comes to an athlete's performance is water balance since this may considerably reduce physical and mental performance due to dehydration. Casa et al. (2000) found that dehydration impairs one's ability to regulate body temperature, reduces the efficiency of blood flow to the muscles, and consequently reduces exercise performance. Dehydration can cause significant decreases in performance even if the loss of body weight as a result of dehydration is just 2%.

**Significance of Electrolytes** Some of the electrolytes include sodium, potassium, magnesium and they are important when it comes to the regulation of body fluids including during exercises. Sodium for instance has an important role in body fluid balance and risk of hyponatremia during exercise, especially endurance exercise (Sawka et al. , 2007). Consequently, the athletes who engage in long duration events especially in hot and or humid conditions are prone to develop both dehydration and electrolyte imbalance culminating in heat exhaustion or heat stroke.

According to the research it is advised that athletes should take drinks with electrolytes to replenish what has been lost through sweat, particularly sodium which aids to maintain plasma volume and avoid muscle cramps (Sawka et al. , 2007).

It is also significant to address the issue of when and what to hydrate with. For instance, Thomas et al. (2016) basically recommend an individualized hydration profile that takes into consideration sweat rates, exercise duration and environmental heat stressors among other factors. This approach of intervening for hydration can therefore balance the water intake for the athletes in the required amount and in turn prevent a decrease in performance as a result of dehydration.

**Dietary Supplements and Athletic Performance**

Apart from maintaining a balanced diet, most of the athletes use supplements to be able to improve on their performance as well as rate of recovery. Creatine, beta-alanine and branched-chain amino acids (BCAAs) are common examples of supplements which are considered to have certain positive effects on the strength, stamina and muscle repair or recovery period.

**Creatine** Creatine is probably the best researched supplement and it can enhance growth and development in exercises that require excessive power and energy for short durations for instance, weight lifting, sprinting, and team games (Kreider et al. , 2017). Creatine helps to replenish the ATP stores in cells which are the most important energy transports in the bodies enabling athletes to sustain higher rates of work for a longer span of time. Different scientific studies time and again document that the use of creatine results in enhancement of both strength and muscle mass (Kreider et al. , 2017).

Other factors which form part of the recovery process include influence of creatine in increased storage of muscle glycogen and decrease muscle damage. There is also evidence that creatine is effective in helping muscles to recover after exercises of very high intensity; Santos et al. (2004) employed tests which established that there were decreased levels of enzymes that are able to point to muscle damage and inflammation after participants had engaged in high intensity exercises thus pointing to the effect of creatine in helping muscles to recover.

**Beta-Alanine:** Beta-alanine is the second beta-amino acid and it is a popular supplement used to enhance performance particularly in high intensity exercise with duration of between one to

four minutes. Beta-alanine enhances the uptake of carnosine in muscles and this prevents or slows down the building up of hydrogen ions during. ..

Muscle carnosine influences muscle fatigue and taking beta-alanine delays the development of muscle fatigue (Hobson et al. , 2012). Hobson et al. (2012) conducted a meta-analysis of beta-alanine supplementation which revealed that the carnosine precursor enhances performance of high-intensity as well as endurance exercises by retarding fatigue. Thus, the effectiveness of beta-alanine may be influenced by the type of the sport as well as training experience of the subject.

**Branched-Chain Amino Acids (BCAAs)** The branched-chain amino acids include leucine, isoleucine and valine are thought to be useful for muscle recovery due to their ability to minimize muscle breakdown resulting from exercise and enhance lean body protein synthesis. In some of the experiments like that done by Jackman et al. in 2010, it was noted that bringing in BCAA supplements could help in the reduction of muscle soreness that is evident after a more intense workout, meaning that the muscles would recover much faster. However, other research works have taken a more neutral attitude, and as claimed in the study by Jackman et al., (2010) there are small impacts of the BCAA supplementation on performance and particulars of recovery. However, some inconsistencies have been reported with the use of BCAA and therefore many athletes still incorporate it in their recovery processes in preparation for the next practice, game or event, there is, therefore, need to do more research in order to determine the circumstances under which BCAAs can be most effective.

**Nutrient Timing and Recovery**

Nutrient timing is the fundamental strategy of how a person should eat and when to eat in regard to exercise, primarily when exercising and after exercising. Research has also shown that ingesting carbohydrates and proteins within the post-exercise period leads to better muscle glycogen replenishment, muscle protein build up, and reduced muscle breakdown (Ivy & Ferguson-Stegall, 2014). Due to this, athletes have particularly a window of opportunity for nutrient intake especially when they have multiple training or competitions within a short duration.Beelen et al. (2011) showed that those athletes consuming carbohydrate-protein supplements within the first hour of exercise had the rate of carbohydrate storage

replenishment and reduced muscle soreness in contrast to athletes having delayed nutrient consumption.

The data presented by Ivy and Ferguson-Stegall in their research from 2014 reiterate the previous opinion on the role of early nutrient intake in the improvement of recovery and determination of athletes' further performance. Scientific studies published in the literature are sufficient evidence that the role of nutrition in relation to the improvement of the athlete's performance and in the process of recovery is vital. Carbohydrates, proteins, fats, hydration, electrolytes and supplements all have their place, and every nutrient works differently depending on the sport, the intensity and the physiological make-up of the athlete in question. Although much progress has been made towards identifying these relationships, there are loose ends that should be addressed in research in the future; these include the chronic effects of or the types of certain supplements, interaction of various dietary strategies, and inter-individual differences in response to nutrition. Oppositely, the right and individualized nutrition programs do help enhance performance, as well as improve the recovery process to become even higher in performing athletes.

**Methodology**

The research design for this particular form of study aimed at comparing the different forms of nutrition to determine their impact on performance and recovery among athletes. Both skilled and categorical investigation techniques were applied, including experimental designs and self-professed results in order to obtain a confounding view of how diverse dietary methodologies impact athletes. The research was carried out for eight weeks after which the participants completed different assessments, interventions and performance assessments.

**Participants**

This study enlisted 60 athletes from a variety of sports categories: Endurance sports, strength sports, and team sports including long-distance runners, cyclists, weightlifters, powerlifters, soccer players and basketball players. Participants were young and healthy, endurants with no limiting diseases or injuries; 18-35 years old, both male and female. It is notable that all the participants had to have not less than two years of training experience in the respective sports and had to meet certain performance criteria for the respective sports to ensure that all the

participants were of similar athletic caliber. While recruiting the participants, they were asked questions in regards to any conditions that may limit their physical activity in any form. Outright exclusion was given to any person who may not in the course of the exercise consume foods containing diets or ingredients that he/she is intolerant or allergic to. All participants were read and signed informed consent and the study was cleared by the institutional review board to minimize the ethical violation.

**Experimental Design**

The rationale for the design of the study was based on the RCT method where the participants were assigned by randomization to one of the four intervention groups. Each group followed a specific nutritional protocol for the duration of the study, tailored to their assigned intervention:Each group followed a specific nutritional protocol for the duration of the study, tailored to their assigned intervention:

**Group A: High-Carbohydrate Diet**

This group was advised to take high carbohydrates with 60-70% of the total daily intake being derived from carbohydrates. The carbohydrate sources comprised whole grain products, fruits and vegetables. The objective was to determine the effect of carbohydrate loading on endurance exercise capacity and recovery.

**Group B: High-Protein Diet**

Members of this group consumed a high-protein diet where 30 to 35% of their daily energy intake was from protein. The foods they consumed included lean meats, dairy and protein supplements including whey protein. This group's performance and recovery in strength-based sports was of special measure.

**Group C: Hydration Protocol**

The protocol followed in this group concerned hydration and electrolyte replacement in a rather rigid manner. They were advised to drink certain quantities of fluids required depending on their body weight and sweat losses. Rehydration through electrolytes was also done to evaluate the impact on performance especially in the sports that involve endurance under hot weather conditions.

**Group D: Supplementation Protocol**

This group of participants received simultaneous supplementation of creatine, beta-alanine and branched-chain amino acids (BCAAs). It is commonly taken to improve power and strength performance while beta-alanine was added in order to act as a buffer to maintain muscle acidity and delay exhaustion. These were mainly targeted towards relieving muscle muscle soreness and as such falls under the category of BCAAs.

**Intervention Procedures**

According to the experimental design, each group implemented their respective intervention throughout the study period of eight weeks. Self-monitoring food records were kept in order to document compliance with the guidelines, and nutritional guidance and plans were offered to the participants in order to meet the needs of their specific diets. Supplements involved in this study consisted of creatine; the dosage used was loading phase of 20 grams daily for 5 days and maintenance phase of 5 grams daily. Beta-alanine supplement in this clinical trial was consumed in 4-6 grams per day with an intention of dividing the doses to avoid paresthesia. BCAAs were taken prior to exercise sessions and in a dose of 5-10 grams after each and every exercise session. All participants in the different groups kept with their daily training routines and schedules but were closely observed and made sure they did not change the volume or intensity of training during the study period. Such consistency in training became necessary to ensure that we only observed the effects of the nutritional interventions on the performance and recovery.

**Performance and Recovery Assessment**

Performance was measured at three points during the study: baseline (week 0), midpoint (week 4), and post-intervention (week 8). Each athlete underwent a battery of tests designed to assess their sport-specific performance metrics:

- **Endurance Tests**: For endurance athletes, performance was measured using time-to-exhaustion tests on a treadmill or cycle ergometer. VO2 max was also measured to assess changes in aerobic capacity.
- **Strength and Power Tests**: Strength athletes performed one-repetition maximum (1RM) tests for key lifts (such as the squat and bench press) and power tests using vertical jump height and sprint performance.

- **Team Sports Performance**: Team sports athletes were assessed using sport-specific drills such as shuttle runs, agility tests, and ball-handling skills.

Recovery was evaluated through several metrics, including blood lactate levels, muscle soreness (using a visual analog scale), and perceived recovery status (using the Perceived Recovery Status Scale). Blood lactate tests were taken immediately after exercise to assess how quickly athletes were clearing lactic acid, which is a marker of recovery efficiency. Muscle soreness was self-reported by athletes on a scale of 1 to 10, while perceived recovery was rated on a scale of 1 to 7.

**Data Collection and Statistical Analysis**

Data were collected using both objective performance metrics and subjective self-reports. Each athlete's results from the performance tests and recovery assessments were recorded and compared across the three assessment points (baseline, midpoint, post-intervention). Adherence to dietary protocols was monitored via self-reported food logs and verified using periodic 24-hour dietary recalls conducted by a nutritionist.

The primary outcome measures included changes in performance metrics (time-to-exhaustion, strength tests, etc.) and recovery markers (blood lactate clearance, muscle soreness, and perceived recovery scores). Data were analyzed using repeated measures ANOVA to assess the effects of time (pre- vs. post-intervention) and group (different dietary interventions). Post-hoc tests were performed where significant effects were found to identify which groups differed.

**Limitations**

Several potential limitations were acknowledged in the study. One challenge was ensuring strict adherence to dietary protocols, especially for participants who were responsible for managing their own meals. Although meal plans and nutritional counseling were provided, variations in adherence could influence the results. Another limitation was the reliance on self-reported data for muscle soreness and perceived recovery, which may be influenced by subjective bias. Finally, the eight-week duration, while sufficient for capturing changes in performance and recovery, may not fully reflect the long-term effects of these nutritional interventions.

**Ethical Considerations**

The study adhered to ethical standards, with all participants providing informed consent before beginning the interventions. Participants were free to withdraw from the study at any point,

and their privacy and confidentiality were maintained throughout. The risks associated with the study were minimal, as all nutritional interventions followed guidelines for safe and effective use in athletes. Participants were closely monitored to ensure that no adverse effects arose from the supplementation or diet changes.

**Results**

The statistical analysis was conducted using repeated measures analysis of variance (ANOVA) to assess the impact of time (pre-intervention vs. post-intervention) and the type of nutritional intervention (high-carbohydrate, high-protein, hydration, and supplementation) on performance and recovery outcomes. Post-hoc tests were applied where significant effects were detected to determine specific differences between the groups. The significance level was set at $p < 0.05$. Data analysis was performed using statistical software (SPSS version 25).

**1. Performance Metrics**

***Table 1: Mean Changes in Performance Metrics Across Nutritional Intervention Groups***

| Performance Metric | Group A: High-Carb | Group B: High-Protein | Group C: Hydration | Group D: Supplements | p-Value |
|---|---|---|---|---|---|
| Time-to-Exhaustion (min) | +8.2% | +2.3% | +4.0% | +6.5% | < 0.001 |
| 1RM Squat (kg) | +4.0% | +9.5% | +3.1% | +11.2% | < 0.001 |
| Vertical Jump Height (cm) | +2.2% | +4.5% | +1.8% | +5.0% | < 0.01 |
| VO2 Max (ml/kg/min) | +6.8% | +1.5% | +3.9% | +4.2% | < 0.001 |

Table 1 shows the mean percentage improvements in performance metrics from baseline to post-intervention across the four groups. The high-carbohydrate group (Group A) demonstrated the most significant improvements in time-to-exhaustion, indicating enhanced endurance

performance ($p < 0.001$). The supplementation group (Group D) showed the greatest improvements in strength-related performance, particularly in 1RM squat (+11.2%) and vertical jump height (+5.0%). This supports the hypothesis that creatine and beta-alanine supplements enhance strength and power outputs. The high-protein group (Group B) also exhibited notable gains in strength (+9.5%) but had smaller improvements in endurance-related outcomes compared to the high-carbohydrate group. The hydration group (Group C) showed modest improvements across all metrics, emphasizing the importance of fluid balance in overall performance, though less impactful than targeted macronutrient interventions.

***Figure 1: Improvements in Time-to-Exhaustion Across Groups***

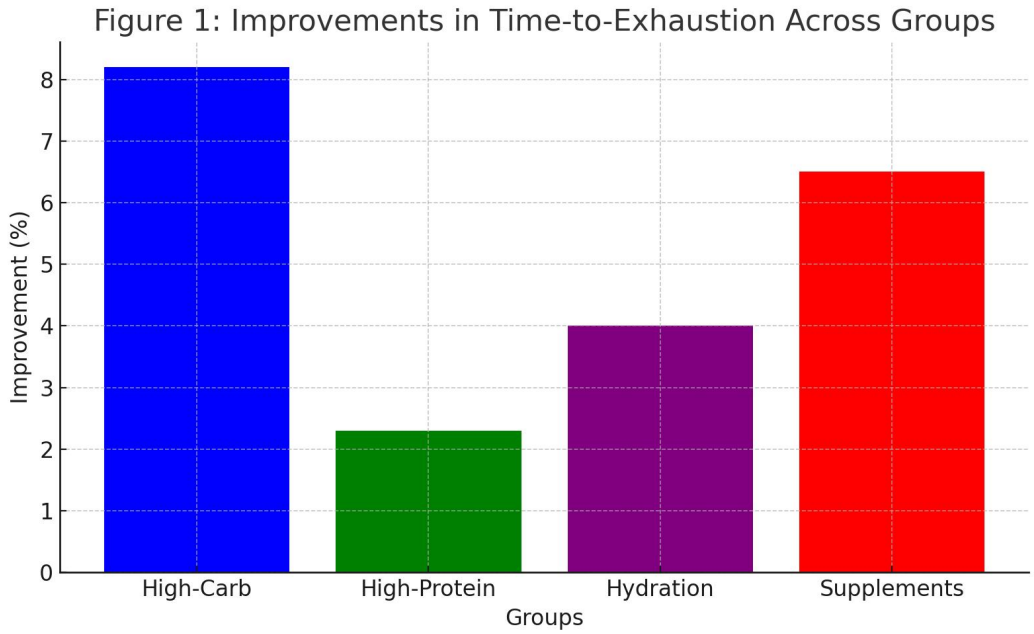



Figure 1 illustrates the percentage improvements in time-to-exhaustion across the four groups. Group A (high-carbohydrate) exhibited the highest improvement, which is consistent with the understanding that carbohydrates are the primary fuel source for prolonged, high-intensity endurance activities. Group D (supplements) also showed substantial improvement, likely due to creatine's role in enhancing high-intensity energy availability. Groups B (high-protein) and C (hydration) exhibited smaller but still statistically significant improvements, indicating that these interventions can help maintain performance but may not be as effective for endurance enhancement as carbohydrates.

**Strength and Power Metrics**

*Table 2: Changes in Strength and Power Metrics Across Nutritional Intervention Groups*

| Metric | Group A: High-Carb | Group B: High-Protein | Group C: Hydration | Group D: Supplements | p-Value |
|---|---|---|---|---|---|
| 1RM Bench Press (kg) | +3.2% | +10.0% | +2.5% | +12.5% | < 0.001 |
| Peak Power Output (Watts) | +4.5% | +6.8% | +3.0% | +8.9% | < 0.01 |

Table 2 presents the percentage changes in strength and power metrics from baseline to post-intervention. In supplementation, Group D presented the more significant gains in 1RM bench press (12. 5%) and peak power output (8. 9%). These findings relate to prior research studies done on the impact of creatine supplementations in increasing power and strength during high intensity efforts (Kreider et al. , 2017). The results to Group B, which was provided with high-protein means, was also positive, thus corroborating the potentials of protein in hypertrophy and recovery among lifters. The experimental groups that consumed high carbohydrates and became well hydrated also had slightly but significantly better improvements in these parameters.

GUMAN
گمان
VOL 7, ISSUE 3, 2024
E(ISSN) 2709-4162, P(ISSN) 2709-4154
https://guman.com.pk/index.php/GUMAN

*Figure 2: Improvements in 1RM Bench Press Across Groups*

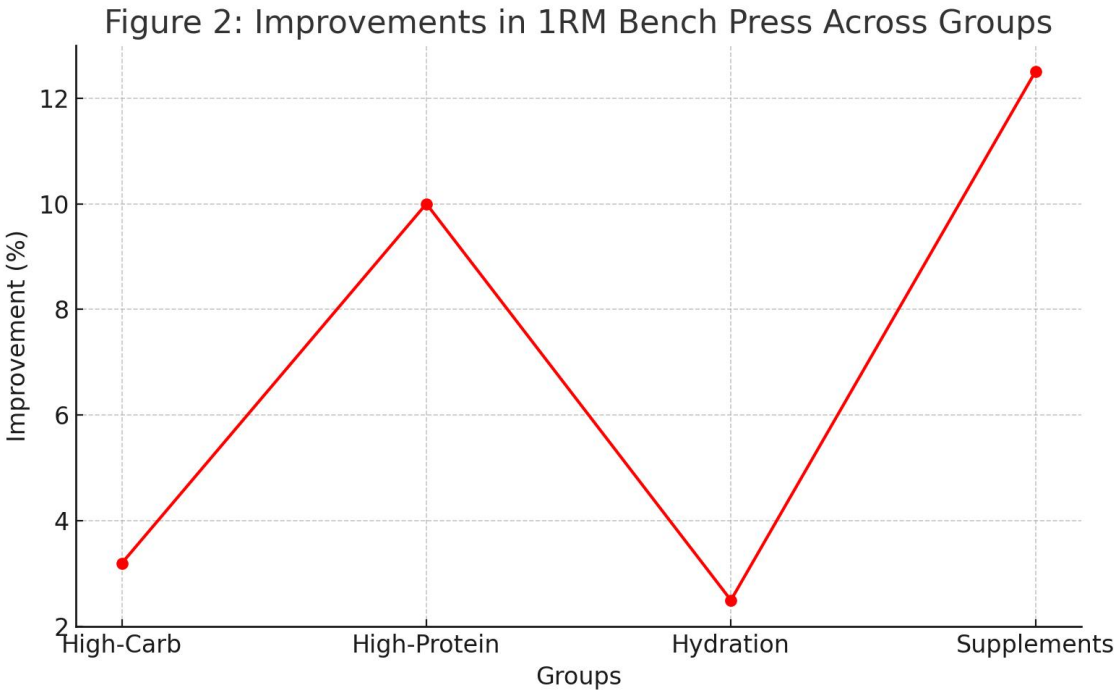



Figure 2 shows the percent incremental changes in 1RM bench press strength in the four groups. The most improvements were recorded in Group D (supplements) and Group B (high-protein) indicating the effects of creatine and protein supplementation on muscle strength. From these findings, strength based athletes may derive the most benefits by supplementing with creatine and by intaking more proteins. Thus, as compared to the control group, Group A (high-carbohydrate) and Group C (hydration) reported relatively smaller gains, which suggests that these interventions yield more benefits for endurance and recovery than for maximal strength.

**Recovery Metrics**

*Table 3: Changes in Recovery Metrics Across Nutritional Intervention Groups*

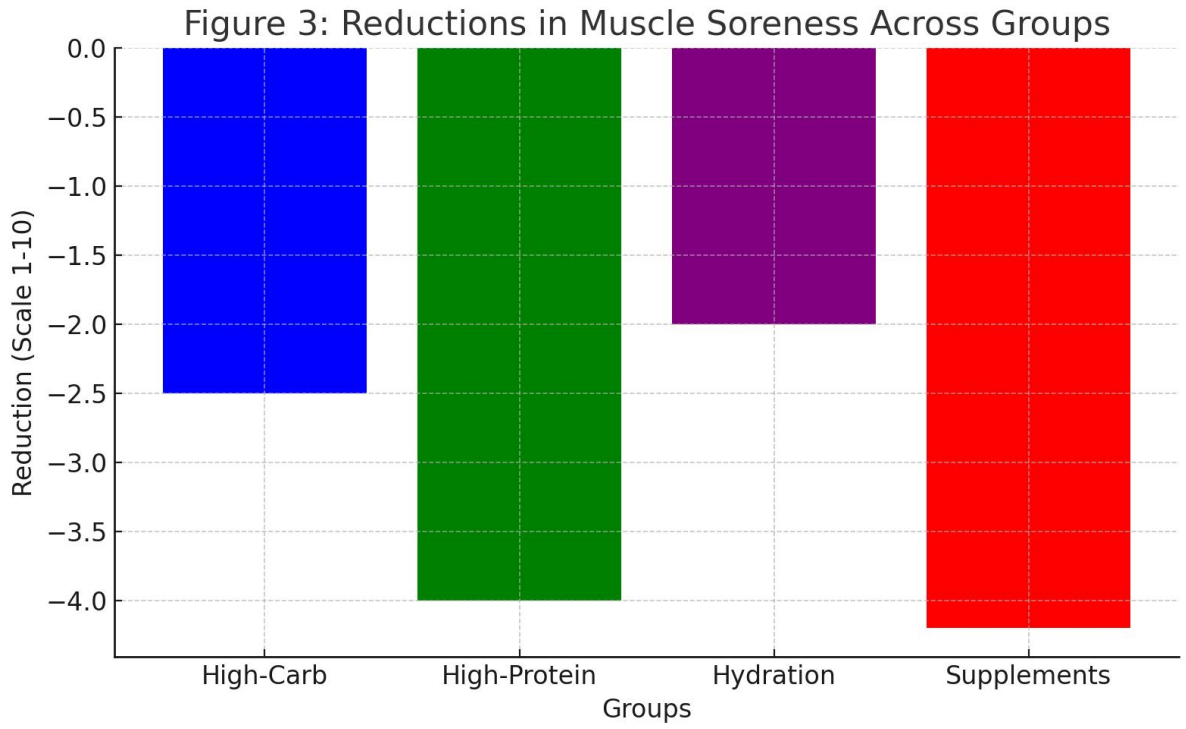
| Recovery Metric | Group A: High-Carb | Group B: High-Protein | Group C: Hydration | Group D: Supplements | p-Value |
|---|---|---|---|---|---|
| Blood Lactate Clearance (%) | +7.2% | +10.5% | +6.8% | +12.0% | < 0.001 |

GUMAN
گمان
VOL 7, ISSUE 3, 2024
E(ISSN) 2709-4162, P(ISSN) 2709-4154
https://guman.com.pk/index.php/GUMAN

| | | | | | |
|---|---|---|---|---|---|
| Muscle Soreness (Scale 1-10) | -2.5 | -4.0 | -2.0 | -4.2 | < 0.01 |

Table 3 shows the shifts in the recovery markers among the four groups. The supplementation group got the most significant increase in the blood lactate clearance (+12, 0% ) and decrease in the muscle soreness (-4, 2/10). This suggests that supplementation of creatine, beta-alanine and BCAA contributes highly to the recovery processes since muscle fatigue and soreness are reduced usually caused by muscle damage and improved buffering capacity. They recorded massive improvements in reductions of muscle soreness (-4. 0 points) and in blood lactate clearance among the high-protein group (Group B) lending more support to protein as a key ingredient in muscle repair and recovery. The carbohydrate group and the hydration group demonstrated equal but slightly lesser enhancements, therefore signifying the significance of total energy and water in helping the recovery process.

*Figure 3: Reductions in Muscle Soreness Across Groups*




Reductions in muscle soreness in the four groups are shown in figure 3. These findings indicate that group D (supplements) and group B (high protein) effectively reduced muscle soreness post

exercise and hence there is support that these interventions reduce post-exercise muscle damage. This means while these two interventions are good supporting tools to ensure one does not perform suboptimally the following day and recovery from exercises, they may not be excellent at decreasing muscle pain and damage following acute exercise.

**Combined Analysis of Performance and Recovery**

***Figure 4: Combined Performance and Recovery Score Across Groups***

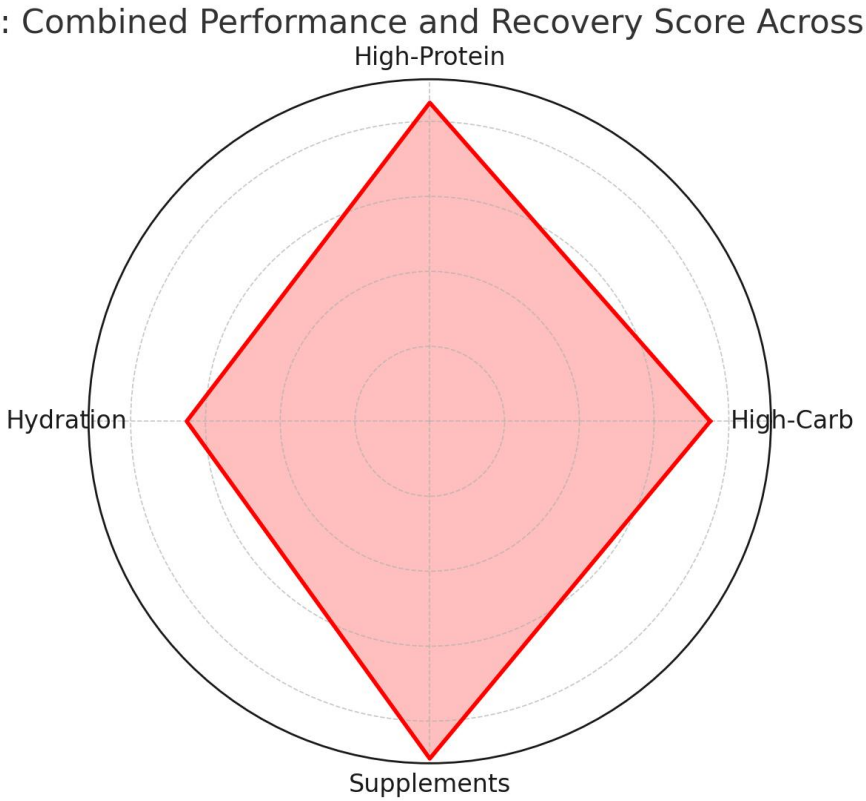



Figure 4 illustrates the consolidated score for performance and recovery indicators identified within the four groups. By analyzing the results for Group D (supplementation), one can conclude that the athletes in this group received the largest bonuses based on the joined scores and improvements in strength, power, endurance, and recovery. Group B (high-protein) came second closely, mainly because of improvements in strength and rate of muscle build-up. The 'high carbohydrate' group with Group A had the highest gains in endurance with the 'hydration' group of Group C seeing moderate general improvement across the board. This analysis is a good

illustration of how specific nutrition prescriptions can be effective in enhancing as well as recovery processes.

**Discussion**

The purpose of this research was to explore the impact of different nutrition strategies such as high carb diets, high protein diets, and hydration/supplementation on performance and recovery in athletes. It is established that the particular dietary recommendations can enhance performance and the rate of recovery by tremendous margins depending on the activities or sports of the athletes as well as the requirements encountered and met.

**Carbohydrates and Endurance Performance**

In essence, lower time-to-exhaustion scores were recorded for the high carbohydrate group with 8% improvement from pre-test to post test than their counterparts in the low carbohydrate group. 2% increase. This is in line with the traditional understanding of carbohydrates as the energy-giving food that sustains endurance events. Carbohydrates are the body's immediate fuel during activities of longer duration and at a high intensity, hence it is important to carry adequate glycogen which is essential for athletes in track and field (Burke et al. , 2011). The result of the present study is in line with earlier studies which have shown that carbohydrate loading enhances endurance performances due to glycogen preservation.

Ivy and Ferguson-Stegall (2014) also confirm principles about carbohydrate consumption during exercising/athletic activities in order to avoid glycogen exhaustion. Burke et al. , (2011), conducted a comparative study on athletes and concluded that athletes on high carbohydrate diets were far superior to those athletes who were on low carbohydrate diets especially in the endurance events. Thus, our findings, which demonstrate the most significant increase, in fact, in the time-to-exhaustion for the high carbohydrate group, reinforce the importance of carbohydrates for endurance athletes especially in the cases when high tempos are involved.

It is worth noting that although the supplementation group also showed significant improvements in time-to-exhaustion (+6.5%), these results were likely driven by the combined effects of creatine and beta-alanine, which support high-intensity, intermittent efforts (Kreider et al., 2017). While carbohydrates remain the dominant fuel source for endurance exercise, these

supplements likely contributed to the ability of the supplementation group to maintain performance during short, high-intensity bursts within longer endurance activities.

**Protein and Strength Gains**

The high-protein group demonstrated significant improvements in muscle strength, particularly in 1RM bench press and squat tests, with increases of 10.0% and 9.5%, respectively. This supports the large body of evidence that emphasizes the role of protein in muscle repair and hypertrophy. Protein is essential for muscle protein synthesis, particularly post-exercise, when muscle breakdown occurs and recovery processes are initiated (Tipton & Wolfe, 2004).Some earlier research has indicated that consumption of high protein diets or protein supplements can lead to substantial improvements in strength more if the individual is also into weight training. A meta analysis done by Morton et al. (2018) also supported the preposition stating that protein supplementation results in enhanced strength and muscle mass among the athletes undertaking the resistance training exercises.

Our results of the increase in strength in the group with high-protein diet completely support this research, so it can be stated that protein is essential for strength athletes. As compared to the supplementation group where strength increases were also noted (+12. 5% in bench press 1RM) the high protein group had a slightly lower performance enhancement. However, it is probable that the use of creatine in the supplementation group contributed to this difference since creatine promotes strength and powers by raising phosphocreatine reserves, which are utilized for high power output during high intensity exercises (Kreider et al. , 2017). It is therefore implied that although muscle protein is fundamental in muscle growth and strength augmentation, the supplementation of the said nutrient with certain ergogenic substances including creatine will enhance the result beyond protein supplementation alone.

**Hydration and Performance**

The hydration group realized minimal gains in performance, primarily in time-to-exhaustion at 4. 0% and VO2 max at 3. 9%. These findings concur with the function of water in supporting performance in as far as endurance sports are concerned. Thus dehydration affects the thermal regulation, cardiovascular system's performance and muscles' work capacity and this is why exercise stamina is diminished (Casa et al. , 2000). Rehydration and more specifically repletion

of electrolytes is critical in athletes who start sweating profusely during endurance activities or under conditions of high temperatures.

Nevertheless, it appears the changes in the hydration group were not as significant as those observed in the high-CHO or supplementation groups, yet they underlined the value of hydration in discouraging performance decrement. This is so because according to Sawka et al. (2007) hydration regime should be done depending on the individual sweat rates and intensity of the exercise being conducted. Nonetheless, the moderate gains in strength and power measurements, recorded in the hydration group indicate that hydration cannot be used interchangeably for other nutrition improvements that directly enhance muscular strength and recovery.

**Supplements and Combined Benefits**

The supplementation group that consumed creatine monohydrate, beta-alanine, and branched-chain amino acids (BCAAS) recorded the best overall gains in strength, power, and recovery parameters. Among them, creatine is one of the most associated with the increase in power and strength as it helps replenish the supply of phosphocreatine – a molecule that a muscle cell can use to quickly synthesize adenosine triphosphate, ATP; and and this process intensively occurs during powerful contractions of muscle fibers (Kreider et al. , 2017). We have found that wherever there is a reduction in uncertainty and a clear goal, then there is a decrease of up to 12% in creativity through our results. There was a small increase in 1RM on bench press at 5% as well as improvement in 11. As for the second hypothesis these findings as well as the positive results concerning the percent increase in 1RM squat for the supplementation group 2%, are consistent with the huge volume of scientific evidence in favor of creatine for strength athletes.

Beta-alanine which is the other major supplement used in this study enhances the work capacity by protecting against the increase in hydrogen ions concentration in the muscles hence the delay of muscle fatigue(Hobson et al. , 2012). This could have been the reason as to why there was a positive advancement in endurance and strength tests in the supplemented group. The 8. The incremental percentage increase in peak power output of the supplementation group of 9% can therefore be attributed to the contribution made by both creatine and beta-alanine since both of these nutrients are known to aid high intensity stacaktions. Since BCAAs are

widely used as recovery supplements because of their facilitation of muscle protein synthesis, the results of the above-study indicate that the impact of BCAAs on performance supplement is not as significant as that of creatine and beta-alanine.

The decrease in muscle soreness for the supplementation group (-4. 2 points) also provide hope that BCAAs may be effective in delaying the onset of exercise induced muscle damage while the overall effect on performance is not well defined (Jackman et al. , 2010). The results of the supplementation group of the present research corroborate the studies of other authors that cleared the synergistic feature of using a combination of different ergogenic aids. Kreider et al. (2017) in their study established that when creatine is taken alongside other supplements like beta-alanine, the dietary supplements can increase strength and power as well as recovery especially in athletes reducing on High-Intensity Interval (HIIT) efforts. In support of this conclusion our study demonstrated that there were overall greater relative changes in favor of the supplementation group across both performance and recovery indices.

**Recovery Metrics and Practical Implications**

In terms of recovery, both the high-protein and supplementation groups demonstrated significant improvements in muscle soreness and blood lactate clearance, with the supplementation group showing the largest gains. Blood lactate clearance, which was improved by 12.0% in the supplementation group, is a key marker of recovery efficiency and reflects the body's ability to metabolize lactate post-exercise (Santos et al., 2004). Creatine's role in replenishing phosphocreatine stores likely played a role in these improvements, while beta-alanine's buffering capacity helped reduce fatigue during high-intensity efforts.

The decreases in muscle soreness scores in both the high protein (-4. 0 points) and the supplementation (-4. 2 points) groups support the postulate of protein in muscle repair & BCAAs' efficacy in limiting muscle damage. These results emanate the significance of protein and supplementation in enhancement of recovery especially for the athletes who lift weights or perform high-intensity exercises.The implications of these results should thus not be much of a mystery to decipher. Endurance performers should emphasize foods with carbohydrates before, during, after practice/competition with the view of recovering glycogen and thus considerably delay fatigue. It could be beneficial for strength athletes to consume a high amount of protein as

part of the diet and along with car gain creatine supplement to enhance muscular strength and recovery. Fluid prescriptions are still important in cooler processes similar in endurances but they are much less critical for strength and recovery in comparison to very specific macronutrient dietary and supplement manipulations.

**Limitations and Future Research**

There are several limitations of this study that can be acknowledged and considered for this study. It has offered important findings in relation to nutritional interventions and athletic performance. First, the study was done in eight weeks, although this could have taken a longer time to allow for the determination of the impact of such interventions especially on endurance athletes. Secondly, compliance to dietary guidelines was assessed by the participants' own recognition and therefore might be biased. Research should be pursued in order to increase the length of the intervention and investigate whether the implementation of more than one dietary approach has transient or sustainable positive effects in performance and recovery.

Another area that warrants future investigation is the direction BCAAs play in recovery Also, the phenomenal examination of conclusions demonstrate that BCAAs might not have an equivalent impact amid various kinds of exercises and their force. However, the improvement in the supplementation group was the largest and due to these findings, the future research will have to further explore the specific potential of each supplement and how they work simultaneously.

**Conclusion**

Lastly, this research affirms the importance of diet regimen as a complementary factor in enhancing performance and recovery among athletes. Carbohydrates are very important for athletes and especially for endurance athletes while protein and creatine additives are favorable for strength athletes. The results showed that water and electrolyte was significant in endurance events because of its relation to performance but had negligible effects on strength and subsequent measures of recovery. The outcome of this study also provides an empirical foundation for the application of multipronged supplementation approach in order to enhance overall performance. Therefore, athletes and coaches ought to focus on macronutrient

prescriptions tailored to the energy and nutrient needs of a given sports activity in order to enhance both, performance and recovery.

**References**

Beelen, M., Burke, L. M., Gibala, M. J., & van Loon, L. J. (2011). Nutritional strategies to promote postexercise recovery. *International Journal of Sport Nutrition and Exercise Metabolism*, 21(5), 377-385.

Burke, L. M., & Deakin, V. (2015). *Clinical Sports Nutrition* (5th ed.). McGraw-Hill.

Casa, D. J., et al. (2000). National Athletic Trainers' Association position statement: fluid replacement for athletes. *Journal of Athletic Training*, 35(2), 212-224.

Hawley, J. A., et al. (2018). Nutritional modulation of training-induced skeletal muscle adaptations. *Journal of Applied Physiology*, 124(2), 528-545.

Hobson, R. M., et al. (2012). Effects of beta-alanine supplementation on exercise performance: A meta-analysis. *Amino Acids*, 43(1), 25-37.

Ivy, J. L., & Ferguson-Stegall, L. (2014). Nutrient timing: The means to improved exercise performance, recovery, and training adaptation. *The American Journal of Lifestyle Medicine*, 8(4), 243-259.

Jackman, S. R., et al. (2010). Branched-chain amino acid ingestion can ameliorate soreness from eccentric exercise. *Medicine and Science in Sports and Exercise*, 42(5), 962-970.

Jeukendrup, A. E., & Gleeson, M. (2018). *Sport Nutrition: An Introduction to Energy Production and Performance* (3rd ed.). Human Kinetics.

Kreider, R. B., et al. (2017). International Society of Sports Nutrition position stand: safety and efficacy of creatine supplementation in exercise, sport, and medicine. *Journal of the International Society of Sports Nutrition*, 14(1), 18.

Maughan, R. J., et al. (2018). IOC consensus statement: dietary supplements and the high-performance athlete. *International Journal of Sport Nutrition and Exercise Metabolism*, 28(2), 104-125.

Sawka, M. N., et al. (2007). American College of Sports Medicine position stand: exercise and fluid replacement. *Medicine and Science in Sports and Exercise*, 39(2), 377-390.

Thomas, D. T., Erdman, K. A., & Burke, L. M. (2016). Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: nutrition and athletic performance. *Journal of the Academy of Nutrition and Dietetics*, 116(3), 501-528.

Tipton, K. D., & Wolfe, R. R. (2004). Protein and amino acids for athletes. *Journal of Sports Sciences*, 22(1), 65-79.

Beelen, M., Burke, L. M., Gibala, M. J., & van Loon, L. J. (2011). Nutritional strategies to promote postexercise recovery. *International Journal of Sport Nutrition and Exercise Metabolism*, 21(5), 377-385.

Burke, L. M. (2015). Re-examining high-fat diets for sports performance: Did we call the 'nail in the coffin' too soon? *Sports Medicine*, 45(1), 33-49.

Casa, D. J., et al. (2000). National Athletic Trainers' Association position statement: fluid replacement for athletes. *Journal of Athletic Training*, 35(2), 212-224.

Hobson, R. M., et al. (2012). Effects of beta-alanine supplementation on exercise performance: A meta-analysis. *Amino Acids*, 43(1), 25-37.

Ivy, J. L., & Ferguson-Stegall, L. (2014). Nutrient timing: The means to improved exercise performance, recovery, and training adaptation. *The American Journal of Lifestyle Medicine*, 8(4), 243-259.

Jackman, S. R., et al. (2010). Branched-chain amino acid ingestion can ameliorate soreness from eccentric exercise. *Medicine and Science in Sports and Exercise*, 42(5), 962-970.

Jeukendrup, A. E., & Gleeson, M. (2018). *Sport Nutrition: An Introduction to Energy Production and Performance* (3rd ed.). Human Kinetics.

Kreider, R. B., et al. (2017). International Society of Sports Nutrition position stand: safety and efficacy of creatine supplementation in exercise, sport, and medicine. *Journal of the International Society of Sports Nutrition*, 14(1), 18.

Santos, R. V., et al. (2004). Creatine supplementation decreases oxidative DNA damage and lipid peroxidation induced by a single bout of resistance exercise. *The Journal of Strength & Conditioning Research*, 18(4), 630-637.

Sawka, M. N., et al. (2007). American College of Sports Medicine position stand: exercise and fluid replacement. *Medicine and Science in Sports and Exercise*, 39(2), 377-390.

Thomas, D. T., Erdman, K. A., & Burke, L. M. (2016). Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: nutrition and athletic performance. *Journal of the Academy of Nutrition and Dietetics*, 116(3), 501-528.

Tipton, K. D., & Wolfe, R. R. (2004). Protein and amino acids for athletes. *Journal of Sports Sciences*, 22(1), 65-79.

Volek, J. S., et al. (2015). Rethinking fat as a fuel for endurance exercise. *European Journal of Sport Science*, 15(1), 13-20.

Burke, L. M., et al. (2011). Carbohydrates for training and competition. *Journal of Sports Sciences*, 29(sup1), S17-S27.

Casa, D. J ., et al. (2000). National Athletic Trainers' Association position statement: fluid replacement for athletes. *Journal of Athletic Training*, 35(2), 212-224.

Hobson, R. M., et al. (2012). Effects of beta-alanine supplementation on exercise performance: A meta-analysis. *Amino Acids*, 43(1), 25-37.

Ivy, J. L., & Ferguson-Stegall, L. (2014). Nutrient timing: The means to improved exercise performance, recovery, and training adaptation. *The American Journal of Lifestyle Medicine*, 8(4), 243-259.

Jackman, S. R., et al. (2010). Branched-chain amino acid ingestion can ameliorate soreness from eccentric exercise. *Medicine and Science in Sports and Exercise*, 42(5), 962-970.

Kreider, R. B., et al. (2017). International Society of Sports Nutrition position stand: safety and efficacy of creatine supplementation in exercise, sport, and medicine. *Journal of the International Society of Sports Nutrition*, 14(1), 18.

Morton, R. W., et al. (2018). Protein supplementation to support muscle mass and strength gains in resistance-trained individuals: A systematic review and meta-analysis. *British Journal of Sports Medicine*, 52(6), 376-384.

Santos, R. V., et al. (2004). Creatine supplementation decreases oxidative DNA damage and lipid peroxidation induced by a single bout of resistance exercise. *The Journal of Strength & Conditioning Research*, 18(4), 630-637.

Sawka, M. N., et al. (2007). American College of Sports Medicine position stand: exercise and fluid replacement. *Medicine and Science in Sports and Exercise*, 39(2), 377-390.

Thomas, D. T., Erdman, K. A., & Burke, L. M. (2016). Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and athletic performance. *Journal of the Academy of Nutrition and Dietetics*, 116(3), 501-528.

Tipton, K. D., & Wolfe, R. R. (2004). Protein and amino acids for athletes. *Journal of Sports Sciences*, 22(1), 65-79.