Carbohydrate and protein ingestion imbalance and gut function in endurance athletes, a possible cause for dysbiosis?

O desequilíbrio na ingestão de carboidratos e proteínas e seus efeitos na função intestinal de atletas de resistência, uma possível causa para a disbiose?

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Abstract

Microbiota is a very important ecosystem of our body and it is directly affected by our nutritional habits. The distribution of macronutrients is one important element that might be helpful or harmful to performance and quality of life of professional and amateur athletes. Athletes are always looking for ways to improve performance although their choices are not always based on science or professional advice. Carbohydrates are the main energy source of our muscles and central nervous system, to warrant the fuel supply, especially for the brain, in cases of low glucose availability, the organism uses a metabolic process that can transform amino acids in glucose, the gluconeogenesis. Carbohydrate low availability comes from the voluntary carbohydrate ingestion reduction, which is believed by the athlete to be a valid strategy to reduce body weight and to improve performance. Associated with carbohydrate reduction there is an automatic increase in protein ingestion that might, indirectly, be the cause of dysbiosis. Dysbiosis is an imbalance in the gut microbiota that negatively affects performance and health and it might be related to the urea concentration in the intestine. Urea concentration might increase due to augmented gluconeogenesis and consequent metabolization of amino acids residues. Dysbiosis is an important and harmful condition that could be avoided by maintaining a proper balance between carbohydrates and protein and the athlete population needs to be warned about that.

Keywords: Athletes; Dysbiosis; Macronutrients; Microbiota.

Resumo

A microbiota é um ecossistema muito importante em nosso corpo e é diretamente afetado pelos nossos hábitos nutricionais. A distribuição de macronutrientes é um elemento importante que pode auxiliar ou atrapalhar a performance e a qualidade de vida do atleta amador ou profissional. Os atletas estão sempre buscando formas de aumentar seu desempenho embora suas escolhas não sejam sempre baseadas em ciência ou em conselhos de profissionais. Os carboidratos são a principal fonte de energia para os músculos e o sistema nervoso central, para garantir o fornecimento de energia para o cérebro em caso de baixa disponibilidade de glicose, o organismo usa um processo metabólico que pode transformar amino ácidos em glicose, a gliconeogênese. A baixa disponibilidade de carboidratos é proveniente da redução voluntária na ingestão, o que os atletas acreditam que pode ser uma estratégia de sucesso para reduzir o peso corporal e melhorar o desempenho. Associada a redução na ingestão de carboidratos, acontece um aumento na ingestão de proteínas que pode, indiretamente, ser a causa da disbiose. A disbiose é um desequilíbrio na microbiota intestinal que afeta negativamente o desempenho e a saúde e pode estar relacionada a concentração de uréia no intestino. A concentração de ureia pode aumentar por conta do aumento na gliconeogênese e a consequente metabolização dos resíduos de amino ácidos utilizados no processo. A disbiose é uma condição importante e perigosa que pode ser evitada pela manutenção de um balanço adequado entre os carboidratos e as proteínas e a população de atletas precisa ser alertada sobre isso.

Palavras-Chave: Atletas; Disbiose; Macronutrientes; Microbiota.

Introduction

The gut microbiome is the environment where the microorganisms that compose the gut microbiota live. This environment is affected by several factors regarding the individual lifestyle and one of the most important is diet. Both macronutrients and micronutrients are important for gut health, and the distribution of macronutrients is more important when we think about athletes and the relationship between nutrients and exercise performance.

The athlete's choice of nutrients should be advised by professionals to match demands and supply in an optimum way, but actual data and reports show that eating habits are sometimes based on rumors, beliefs and even harmful notions that negatively influence health and performance.

Dysbiosis and High Protein ingestion

The gut microbiota indirectly influences several markers of exercise performance, recovery and disease patterns, through cytokines and myokines signaling, controlling the hypothalamic-pituitary-adrenal axis activation and affecting the metabolic pathways related to exercise performance (Mohr et al., 2020; Wegierska et al., 2022).

The gut microorganisms play a significant role in nutrients absorption, vitamin synthesis, energy production, inflammatory modulation and immune response aiding collectively in human health.

Beyond that, the gut microbiome, modulating the immune system and gastrointestinal health, plays an important role in the athlete health, well-being and more specifically in his or her performance (Mohr et al., 2020).

On the other hand, when this important system shows problems, the consequences are felt both in health and in performance.

Dysbiosis and abdominal discomfort negatively affect the athletes with consequent loss of performance and increased number of injuries (Moreno-Pérez et al., 2018; Wegierska et al., 2022).

In clinical practice we observe frequent complaints of dysbiosis symptoms from amateur and professional athletes. Situations such as abdominal distension, gases, pain and intense abdominal discomfort are related to the use of a large daily dose of different sources of protein. This observation led to an underlying problem regarding the imbalance between the ingestion of carbohydrates and protein and the establishment of dysbiosis.

Reduced Carbohydrate Ingestion and its Implications

A very popular idea is that an athlete can reduce weight by reducing carbohydrate ingestion and that might improve performance.

The weight reduction pursued by athletes is based on the notion of a power/weight relationship (PWR) that might favor performance in a variety of sports.

One important paper published by Slater et al., (2019), approaches the nutrition and performance issue in speed or power athletes. The study mentions that the carbohydrate need for training and competition is somewhere between 3 to 6 g/kg of body weight per day, and it is also important that the athlete reaches his/her competitive peak with a low body fat percentage in order to improve the PWR. The study also mentions that other nutritional strategies might be used in an acute way to improve this relationship, but they might be used under careful supervision of experienced professionals.

In clinical practice, we have been observing that athletes reduce carbohydrate and caloric consumption acutely to lose weight (with frequent losses of muscle mass), to improve performance through the PWR. This acute reduction in caloric consumption, that usually means less carbohydrate consumption, seems to be an inadequate effort to decrease body fat percentage.

This notion is supported by some evidence such as the published by Lunn et al., (2009). The authors state that PWR is a popular and anecdotal measure of both aerobic and anaerobic performance in competitive cyclists. They also state that improved PWR might be achieved using training techniques related to power production improvement, body weight reduction or yet a combination of both.

Huovinen et al., (2015) show that a quick weight reduction, due to carbohydrate ingestion reduction with protein ingestion maintenance, might improve the weight/power relationship without changes in the hormone profile or causing muscle mass reduction in athletes. The study lasted 4 weeks and 0.5kg of body weight was lost per week. Some interesting observations were that athletes with more than 10% of body fat lost weight without losing muscle mass, although thinner athletes lost muscle mass. Moreover, the authors reported mild impairment in the capacity to maintain acid base balance. This study focused on performance improvement of elite athletes, with neither data on their health nor other information that would address the influence of these extreme nutritional strategies on other organic systems such as the immunological or the nervous system.

Several studies (Peeling et al., 2023; Neglia, 2021; Wells et al., 2020) demonstrate that low caloric ingestion and diets that are not balanced are frequent for amateur or professional athletes. Although carbohydrate efficacy in restoring muscle and liver glycogen is a scientific consensus, some athletes are still resistant to consuming the adequate amount of it.

Carbohydrate consumption resistance is not only recurrent in elite athletes. Amateur athletes are also turning resistant, probably due to a popular notion that carbohydrates might negatively affect body composition.

Proper carbohydrate ingestion contributes to adequate body composition and weight, optimizing the training results and improving health. Negative caloric balance, usually accompanied by lower micronutrient ingestion can cause muscle mass loss, hormonal disfunction, lower bone mineral density, chronic fatigue, musculoskeletal injuries and infectious diseases. Interestingly, those are among the main features of overtraining (de Carvalho et al., 2003).

High protein and low carbohydrate ingestion can not only be counterproductive, but it can really be harmful. Several athletes that complain about dysbiosis symptoms show blood urea values above the referred as normal by most of the clinical analysis labs.

Gluconeogenesis, Urea and Dysbiosis

One possible hypothesis is that the high urea concentration could favor the dysbiosis establishment with consequent intense gastrointestinal stress.

That high urea concentration might be connected to another important observation made from food intake records. We have observed an imbalance in the carbohydrate/protein ratio with a protein consumption highly above the recommended amount and a carbohydrate consumption below the sports and performance guidelines. Moreover, these subjects show a calorie ingestion that doesn´t match the caloric expenditure of the activities they do.

The Brazilian Sports Medicine Society guideline suggests that carbohydrates should account to 60 to 70% of the daily caloric ingestion regarding sports training. To optimize muscle recovery, carbohydrate consumption should be between 5 and 8g/kg of body weight per day. Long or intense training sessions require even 10g/kg of body weight per day to fully recover muscle glycogen or to promote muscle mass increase (grade I and level A evidence) (Hernandez & Nahas, 2009).

For endurance athletes, protein has an auxiliar role in supplying energy to the training session, with a 1.2 to 1.6g/kg of body weight daily requirement. To Strength athletes, protein is essential as it serves as raw material to muscle tissue synthesis. Their daily requirement is around 1.4 to 1.8g/kg of body weight (grade I and level a evidence) (Hernandez & Nahas, 2009).

According to the guideline, nutritional caloric needs are between 1.5 and 1.7 times the energy produced, which, in general, means a consumption of 37 to 41 kcal/kg of body weight per day. Depending on the athlete goals the caloric need is larger reaching up to 30 to 50 kcal/kg of body weight per day.

Although these data are already sound and clear, all the different eating methods and habits mentioned before are very popular and frequent among athletes. The pitfall is that while they are looking at performance and aesthetics, the metabolic imbalance that might be associated with dysbiosis goes unnoticed.

Protein, whether from diet or from muscle catabolism can be degraded to amino acids to be oxidized (becoming fuel to produce ATP in the cell respiratory process). In an alternative pathway, some glycogenic amino acids can be converted to alanine, which, in turn, will be converted to glucose in the liver, to maintain glucose blood levels a requirement of the nervous system and red blood cells (Schutz, 2011). This process, known as Gluconeogenesis, is especially important when the body is in caloric deficit or carbohydrate restriction (without going to ketosis).

Hiromatsu et al., (2023) illustrates this dynamic process with an experimental design that compares two athlete groups in a long effort. One of the groups had high carbohydrate ingestion and the other had moderate carbohydrate ingestion. The groups showed no significant difference in the interstitial glucose concentration, one important marker of the consumption and production of metabolic glucose during exercise. This absence of difference is due to the different contributions of hepatic glycogenolysis and gluconeogenesis from both groups.

The gluconeogenesis process uses amino acids that come from the muscles or diet. In the process, the amino groups are removed, and the transamination and deamination process occur with consequent urea synthesis. The carbon residues are metabolized in the gluconeogenic precursors such as pyruvate, succinyl CoA, fumarate, alpha ketoglutarate and oxalacetate, or can be used in the ketone bodies production (Palmer and Clegg, 2021).

After leaving the liver by diffusion, urea is transported in the bloodstream to the kidneys where it is filtered and excreted in the urine. Part of the urea diffuses from the blood to the intestine where it is cleaved in CO2 and NH3 by bacterial urease. This ammonia is partially excreted in the stool and partially reabsorbed to the blood (Liu et al., 2018).

The chain of ideas above suggests that more important than the performance and aesthetic aspects, an imbalance between macronutrients, more specifically carbohydrates and protein might lead to serious metabolic problems such as intestinal dysbiosis.

Conclusion

Significant reductions in carbohydrate ingestion and increase in protein ingestion cause an overload in protein metabolism, for instance stimulating protein use as energy, which leads to an increase in urea production. It's a reasonable conclusion that the return of this urea to the intestine can promote dysbiosis installation.

This phenomenon that seems to be of mild significance, involves behavioral, cognitive and clinical aspects that impact on the amateur and professional athlete's life and health throughout the years and does not give them better results than traditional and safe practices.

This biochemical hypothesis based on clinical observation can be verified by an experimental study that monitors behavior, symptoms and clinical exams in a longitudinal design.

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Declaração Ética

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