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Carbohydrate intake results in lower suppression of salivary immunoglobulin A in judokas

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ABSTRACT

Objective: This study investigated the salivary immunoglobulin A response to carbohydrate supplementation during judo training.
Method: Sixteen judokas were randomly assigned to one of two conditions: Carbohydrate solution and Placebo solution in a double-blind design. Saliva samples were collected at rest, immediately after the training session and 1 h after the training session.
Results: The concentration of the salivary immunoglobulin A decreased during the training session in both conditions ($p = 0.0002$) as well as at 1 h after the training session in the placebo solution condition ($p = 0.035$). The rate of salivary flow decreased during the training session in the placebo solution condition ($p = 0.04$).
Conclusion: Carbohydrate solution consumption during training session did not affect the athletes oral immunity, however, in the recovery period an upper-respiratory tract protection was observed.

La ingesta de carbohidratos induce una menor supresión de la inmunoglobulina A salival en yudocas

Palabras clave:
Artes Marciales
Fenómenos Fisiológicos en la Nutrición Deportiva
Inmunidad Mucosa
Inmunoglobulina A

RESUMEN

Objetivo: El presente estudio investigó la respuesta de la inmunoglobulina A salival a la suplementación de hidrato de carbono durante el entrenamiento de judo.
Método: Dieceiséis yudocas fueron asignados de forma aleatoria a una de dos condiciones: solución de carbohidratos y solución de placebo en un diseño doble ciego. Las muestras de saliva fueron recogidas en reposo, inmediatamente después de la sesión de entrenamiento y una hora después de la sesión de entrenamiento.
Resultados: La concentración de inmunoglobulina A salival disminuyó durante la sesión de entrenamiento en ambas condiciones ($p = 0.0002$), al igual que una hora después de la sesión de entrenamiento en la condición de solución de placebo ($p = 0.035$). La tasa de flujo salival decreció durante la sesión de entrenamiento en la condición de solución de placebo ($p = 0.04$).
Conclusión: El consumo de la solución de carbohidratos durante la sesión de entrenamiento no afectó a la inmunidad oral de los atletas; sin embargo, en el período de recuperación se observó una protección del tracto respiratorio superior.

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Ingestão de carboidrato resulta em menor supressão da imunoglobulina A salivar em judocas

Palavras-chave:
Artes marciais
Fenômenos Fisiológicos da Nutrição Esportiva
Imunidade nas Mucosas
Imunoglobulina A

R E S U M O

Objetivo: O presente estudo investigou a resposta imunoglobulina A Salivar frente a suplementação de carboidrato durante o treino de judô.
Método: Dezesseis judocas foram aleatoriamente randomizados, em delineamento duplo-cego nas condições: solução carboidrato e solução placebo. Para mensuração da imunoglobulina A Salivar, a saliva foi coletada no início da sessão de treino, imediatamente após o término e uma hora após o término (1-h Pós-E).
Resultados: A concentração de imunoglobulina A Salivar diminuiu logo após o treino, independente da solução ($p = 0.0002$). No momento uma hora apos o termino frente ao imediatamente apos o termino, houve menor concentração de imunoglobulina A Salivar somente para a condição solução placebo ($p = 0.035$). A taxa de fluxo salivar diminuiu significativamente somente na condição solução placebo ($p = 0.04$).
Conclusão: A Ingestão de solução carboidrato durante a sessão de treino não impediu a imunodepressão da imunoglobulina A Salivar de judocas imediatamente após o treino, mas exerceu proteção à imunidade do trato respiratório superior 1-h após.

Introduction

The main role of salivary immunoglobulin A (S-IgA) is to protect the upper respiratory tract against colonization of pathogens and virus replication.[1] Such protective effect appears to be dependent mainly on its amount and rate of secretion into the mucosa surface.[2] Thus, it suggests that changes in the secretion of S-IgA can be a potential indicator for the exercise-mediated effects on mucosal protection.[1]

The secretion rate of S-IgA is inversely associated with the incidence of upper respiratory tract infections (URTI),[1] however, scientific evidences suggest that athletes engaged in intense training exhibit an increased risk of URTI, as compared to moderate training.[2] The physiological mechanisms underlying this clinical manifestation are not completely clear, nevertheless, there are speculations regarding immune system changes, such as decrease in S-IgA concentration associated with exercise.[1] For instance, Gleeson et al[3] found that elite swimmers, submitted to intense training, showed URTI associated with concentration of S-IgA. In addition, athletes competing in combat grappling sports (i.e. judo, wrestling and jiu-jitsu) are subjected to pre-competitive anxiety and body contact which increases even more the stress that fighters are submitted.[4] It is believed that such condition may predispose combat athletes to immunosuppressive response.

During prolonged exercise, the immune responses associated to physical stress can be amended by the carbohydrate, possibly it is related with a higher concentration of blood glucose.[3,5] There is no consensus on the influence of carbohydrate intake in the S-IgA response. While some studies show no benefits of either aerobic[6] or resistance training[7] against placebo, others observed protective effect on the mucosal immunity.[8,9] This issue is relevant to combat sports and studies have investigated the effect such sports training on S-IgA.[4,10–14] However, studies on the immune responses of S-IgA after combat sports training with carbohydrate consumption are rare. Therefore, the present study was designed to assess the responses of S-IgA in judo athletes with or without carbohydrate intake during a training session. We hypothesized that the carbohydrate consumption during training session induces immunoprotective responses.

Method

Subjects

Based on our pilot study ($n = 4$), as well as the specific literature,[5,10,14] we estimated a representative sample size based on the S-IgA response. To achieve 80% statistical power, we calculated a minimum sample of 14 subjects to reach a decrease in 10 mg mL^{-1} when comparing S-IgA concentration between groups (5.2 Granmo, IMIM, Barcelona, Spain). The final sample consisted of 16 male judokas (age: 24.1 ± 2.6 years; Body mass: 76.8 ± 9.4 kg, Body fat: 14.5 ± 4.3%). The following criteria were used: previous experience (≥Purple belt) and fitness level (≥1 year training for competition). All individuals were in the pre-competitive phase (<2 months to the regional championship) and none had a rapid weight loss and/or consumption of immunomodulatory drug. This study was approved by the Institutional Research Ethics Committee.

Experimental design

This was a double-blind crossover design study. The sample collections underwent two training sessions with three days interval between them. In the first session, eight subjects were randomly assigned to one of two conditions: (a) consumption of carbohydrate solution (CHO); and (b) consumption of placebo solution (PLA). The treatments were reversed in the second session. Fig. 1 shows the organization flow chart of data collection.

Each session lasted for 120-min (40-min gymnastics, 40-min technical training and 40-min *Randori*). The gymnastics training was composed of warm-up, stretching and local and conditioning exercises. The technical training was composed of specific judo movements (ukemi), techniques (uchi- komi) and throwing (nage-komi). The *Randori* consisted of 10 fights of 4 minutes each, 3 groundwork (ne-waza) and 7 standing combats (tachi-waza). This training protocol was previously applied to Brazilian[5] and Japoneses judokas.[10] After the training session, athletes rested for 60 min in the dojo and waited for the last collection of saliva.

The subjects were recommended to abstain of exercise training (24 h) and fasting (8 h) before the experimental training session.

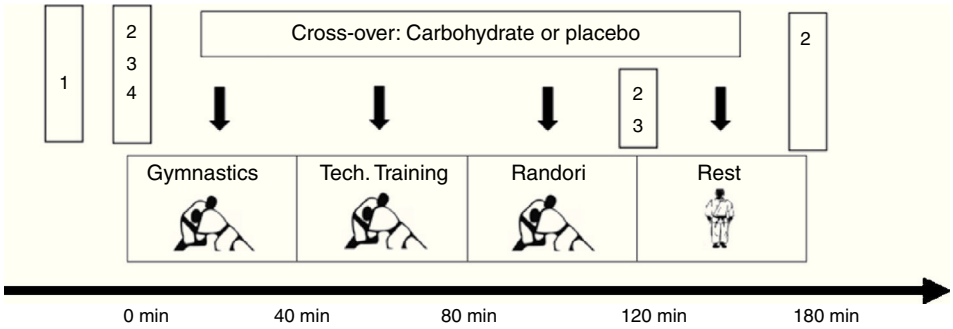

Fig. 1. Organization of procedures followed in data collection. The numbers on the bars represent the measurements in pre, post-E and 1-h post-E. 1, sample selection and anthropometry; 2, saliva collection; 3, body mass; 4, pre-exercise meal.

The experimental procedures started at 07:00 AM when the first collection of saliva occurred (pre-E). Soon after, we offered a personalized breakfast (pre-exercise meal). An hour after breakfast, the athletes started the training session. Immediately after the training session (post-E) and 1 h later (1 h post-E) were collected other saliva samples.

The athletes' height was determined and their body mass was measured at the beginning and the end of each training session. Body composition was estimated using a skinfold equation (triceps, subscapular and abdominal).[15] The body density was estimated using the Wrestlers equation for college Thorland et al.[15] The percentage of body fat (% BF) was estimated using the Brožek et al[16] equation.

Saliva samples were collected in plastic tubes (7 mL) during a period of 2 min at resting position (seated)[17] and stored at −20 °C for future analysis. The mass in grams of saliva was assumed to be equal to milliliters of secreted saliva, since the specific density is very close to 1.0 g mL^{-1}.[18] Then, the salivary flow rate (mL min^{-1}) was obtained. The concentration of S-IgA (mg dL^{-1}) was determined by enzymatic immunoassay (ELISA).[19] The intra-assay coefficient of variation was 7.6%.

After evaluation of eating habits through 24-h recording, we calculated the personal diet consumption during the three days prior to the beginning of each experimental training session.[20] The International Physical Activity Questionnaire (IPAQ) was applied to estimate the athlete's physical activity level. The diet content 90–110% [408 ± 49 kcal; carbohydrate (1 g^{-1}kg^{-1} BM) and 18 g protein (0.4 g kg^{-1} BM)] of Estimated Energy Requirement (EER) according to gender, age, weight, height and physical activity level of each athlete.[21] The pre-exercise meal corresponded to 14% of energy of individual EER and included industrialized juice, white bread, cream cheese and apple. Diets were calculated using the Diet- Pro software – version 4.0. The nutritional procedures in this study were adapted from Brito et al.[5]

A commercial sport drink (Gatorade®) with the following composition was used [carbohydrate – sucrose and fructose (6 g/100 mL); sodium (45 mg/100 mL); potassium (12 mg/100 mL); and chloride (42 mg/100 mL)] as carbohydrate solution. The PLA solution was composed of sodium (87 mg/100 mL) and chloride (80 mg/100 mL). The athletes were hydrated at 0, 15, 30, 45, 60, 75, 90, 105 and 120 min of the training session and 135, 150, 165 and 180 min during the post-training recovery. The solutions were served by an external researcher, thus ensuring the double-blind nature of this study, and the amount of fluid intake was monitored.

Statistical analysis

Normal distribution of the data was checked by Shapiro–Wilks test. Homogeneity and sphericity of variance were checked before statistical analysis (Mauchly test). To verify the changes in S-IgA induced by exercise and conditions (i.e. hydration type), we used repeated measures ANOVA (carbohydrate or PLA ×3 times of measurement). When differences were significant, the post hoc Bonferroni test was applied. To compare means obtained by different conditions we used the independent *t*-test. Data were analyzed using SAS software (IBM® software's) and significance was at $p < 0.05$.

Table 1
Body mass and fluid intake at different times and conditions.

Condition	Pre-E (kg)	Post-E (kg)	Fluid intake (L)	*p* Value
CHO	77.4 ± 9.8	76.0 ± 9.6	~2.1	$p = 0.342$
PLA	77.3 ± 9.5	76.4 ± 9.3	~2.1	$p = 0.401$

CHO: group carbohydrate solution; PLA: group placebo solution; Pre-E: pre-training; Post-E: immediately post-training.

Results

The body weight did not change ($p > 0.05$) significantly between measurements and conditions (Table 1).

S-IgA data are presented in Fig. 2. There was a reduction of S-IgA concentration from pre- to post-E in both conditions (CHO: 21.7 μg mL^{-1} vs 8.6 μg mL^{-1}, respectively, $p = 0.0002$ and PLA: 20.2 μg mL^{-1} vs 7.1 μg mL^{-1}, respectively, $p = 0.0012$) (Fig. 2A). There was no difference in the concentration of S-IgA between conditions ($p = 0.98$) measured at different times. We observed a reduction in the concentration of S-IgA from Post-E to 1 h Post-E, only for the PLA condition (7.1 μg mL^{-1} vs 5.7 mL^{-1}, $p = 0.035$). Salivary flow rate decreased significantly from pre- to post-E, only for the PLA condition (2.3 mL min^{-1} vs. 1.4 mL min^{-1}, $p = 0.012$, respectively) (Fig. 2B).

Discussion

This study investigated the S-IgA secretion after a judo training session with or without carbohydrate intake. The principal outcomes indicated that carbohydrate intake during judo training results in immunoprotective mucosal effect 1 h after the training session.

We believe that the nutritional action that preceded the training has offered a substantial amount of carbohydrate (1 g kg BM^{-1}) which maintained the blood glucose concentration. It is possible that the pre-exercise meal lead to similar immune and hormonal responses after the 120-min exercise session in both experimental conditions in this study. There is evidence that exogenous carbohydrate intake during exercise can influence the immune response by maintaining the blood glucose level, thereby reducing the expression of catabolic hormones.[22] In fact, it has been shown that carbohydrate intake reduces disturbances in the immune system of endurance athletes[8,23] as well as in judokas during training sessions.[5,22]

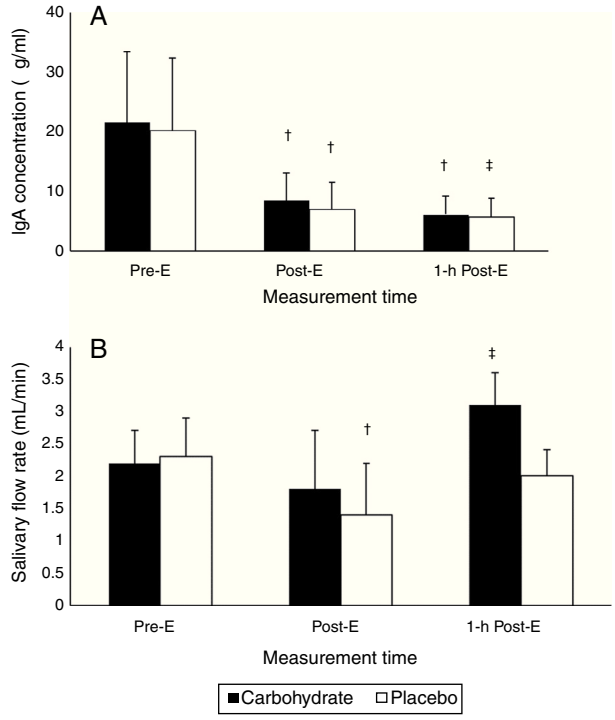

Fig. 2. (A) Average IgA-S in pre, post- E and 1-h post-E times. (B) Average salivary flow rate in pre, post-E and 1-h post-E times. †, significant difference as compared to pre-E ($p < 0.05$); ‡, significant difference between post-E and 1-h post-E ($p < 0.05$).

The concentration of S-IgA during exercise is influenced by the sympathetic nervous system. Although we did not observe statistically significant difference in S-IgA between conditions at Post-E, there was a reduction in the salivary flow rate for the PLA condition. S-IgA concentration decreased by 60% and 65% after 120 min of training in athletes who consumed carbohydrate and PLA, respectively, thus confirming the results found by Nieman et al[24] in ultramarathon after 160-km race. Nieman et al[24] observed that 25% of athletes had URTI two weeks after the race. In the present study, only one out of 16 athletes developed symptoms of URTI a week after the training sessions (i.e. throat infection). Although S-IgA is not the unique determining factor for URTI, it could be used as an index to check immunosuppression and possible causal factor for susceptibility to URTI in athletes.

Evidence indicates that chronic exercise has a cumulative effect on S-IgA.[2] Excessive training and competition associated with psychological stress appears to reduce the S-IgA concentration, and it is suggested that overtraining is associated to psychological stress and chronic suppression of antibodies produced by B cells.[1] In fact, Umeda et al.[14] observed a significant decrease in plasma IgA in judokas after training of similar duration as that in the present study. In addition, highly trained judokas presented plasma IgA suppression after training either immediately or after 3 months.[11] It should be noted, however, that IgA immunosuppression was avoided in judokas who underwent progressive reduction in pre-competition training load (tapering), which allowed appropriate recover and adequate preparation to competition.[12]

The average time of 1 h after training to restore the S-IgA to resting values has been reported.[6] In contrast, Mackinnon et al[2] demonstrated a complete recovery of S-IgA to resting levels 24 h after an intense cycling session. Hübner-wozniak et al.[25] did not observe recovery of S-IgA to resting levels 1 h after the cycling exercise. In line with these findings, our study also demonstrated that athletes who consumed PLA tended to exhibit more intense immunosuppressive response. Such divergent times to restore S-IgA concentration to resting values warrant further investigations, especially in combat sports athletes.

The hydration protocol used in the present study aimed to avoid significant reduction in body mass from pre- to post-E. Indeed, the maintenance of body mass has allowed us to eliminate the bias associated with dehydration on immunity, thus isolating the effect of training and energy intake. Reductions in circulating S-IgA were observed in Japanese judokas subjected to dehydration (~3.5%).[13] Moreover, Chishaki et al.[10] observed a decrease in plasma concentrations of IgA in judokas with moderate or severe dehydration during training session of about 120 min.

Our results have practical applications as it indicate to coaches and athletes the benefit of energy replenishment, allowing the judokas to prepare adequately for competitions avoiding IgA suppression. However, it is noteworthy that the main effect of carbohydrate occurred after training. In addition, forced stops during training could be counterproductive, therefore, carbohydrate consumption either after training or during *randori* interval is indicated.

Future studies on catabolic hormones (e.g. cortisol, adrenaline) associated with the S-IgA response in simulated competition or competition would be interesting since the demands of physical and mental stress are different in training session,[26] competition or simulated competition.[4,26]

In conclusion, the consumption of sport drink containing carbohydrate contributes to the maintenance of the salivary flow rate with no effect on the S-IgA concentration. However, after 1 h of training recovery carbohydrate intake attenuated the decrease in S-IgA concentration in judokas.

Ethical disclosures

Protection of human and animal subjects. The authors declare that the procedures followed were in accordance with the regulations of the relevant clinical research ethics committee and with those of the Code of Ethics of the World Medical Association (Declaration of Helsinki).

Confidentiality of data. The authors declare that no patient data appear in this article.

Right to privacy and informed consent. The authors declare that no patient data appear in this article.

Conflicts of interest

The authors have no conflicts of interest to declare.

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