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Prior carbohydrate ingestion increases hand grip strength and reduced subjective perception of effort in a Brazilian Jiu-Jitsu fight

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Key-words: martial arts, food supplementation, Muscle Strength Dynamometer, biochemistry, combat sport

Abstract
Introduction. The effects of pre-exercise carbohydrate (CHO) intake are already well established in the literature, and generally address the outcomes of CHO restriction on physical abilities. The scarcity of studies investigating consumption at different moments and in specific populations is highlighted.
Aim. The aim of the present study was to evaluate hand grip strength (HGS) and blood glucose, and perceived exertion in Brazilian Jiu-Jitsu (BJJ) athletes after carbohydrate intake at different times.
Materials and Methods. In total, 12 athletes participated, divided into three groups (n=4): Control Group (CG = without supplementation); Experimental group 1 (GE1 = supplementation immediately before a fight); and Experimental group 2 (GE2 = supplementation 30 minutes before a fight). HGS was measured with a JAMAR® hydraulic analog dynamometer in the moments before and after the fight. Blood glucose was measured at pre and post fight and 5, 10, and 15 minutes after the fight using the colorimetric method with a spectrophotometer. The perception of the intensity of effort was verified using an adapted Borg scale.
Results. Significant increases in HGS and blood glucose were observed between test intervals only for GE2. The perception of effort was greater for CG.
Conclusion. Ingestion of CHO before a BJJ fight seems to alleviate subjectively-perceived fatigue and significantly increases HGS and blood glucose levels only when ingested 30 minutes prior to exercise.

Introduction

The increase in the use of dietary supplements occurs in common with the increase in people who initiate physical activity, whether recreational or professional [Zilch *et al.* 2012]. Best performance is the continuous goal of all these individuals. For professional athletes, in particular, large energy stores are required during competition. The search for large energy stores leads to the use of supplementation to increase energy to perform exercise [Huttermann, Memmert 2014]. According to Paiva *et al.* [2016], CHO-based supplements stand out as energy supplements.

The effects of CHO ingestion before exercise are already well established in the literature, demonstrating that this practice is able to raise the levels of hepatic and muscular glycogen, improving the metabolic efficiency for ATP resynthesis which, associated with the ergogenic effect, are responsible for preparing the individual and improving performance during medium and long term exercise [Hargreaves *et al.* 2007; Finger *et al.* 2018]. On the other hand, studies in the literature commonly address the outcomes resulting from CHO restriction on physical abilities, such as strength [Costa 2016].

Although the consumption of pre-competition CHO is widespread in the athletic environment, there is a scarcity of and scientific gaps in studies that investigate consumption at different moments and which verify the correlation of these moments with the acute posterior performance in specific athletic populations, for exam-

ple, BJJ athletes. BJJ is an internationally renowned sport created in Brazil after Carlos Gracie changed the international rules of Japanese jiu-jitsu, and subsequently exported to the whole world, including Japan [Del Vecchio *et al.* 2007]. BJJ is currently the basis for techniques in highly popular solo fighting events, such as MMA (Mixed Martial Arts) [Andreato *et al.* 2011].

Currently, the literature involving CHO and athletes demonstrates greater concern regarding the relationship of this supplementation with weight loss [Tinsley, Willoughby 2016], leaving a gap with respect to sports performance [Helge 2017]. Thus, it is extremely important to investigate CHO supplementation strategies for a specific group (professional BJJ fighters) that do not negatively affect athlete's performance. In this sense, it seems pertinent to elaborate studies that investigate this specific sport profile, since the findings can assist in the inclusion of strategies that improve the performance of these athletes.

Therefore, the aim of the present study was to investigate the effects of CHO intake before a fight, at different times, on HGS, blood glucose, and perceived exertion in professional BJJ athletes.

Materials and Methods

Participants

The sample consisted of twelve professional BJJ athletes, with minimum blue belt graduation (age 20-33, height 1.77 ± 0.07m, body mass 83.18 ± 12.93 kg, and body mass index 26.57 ± 4.19), who had participated in at least two national competitions or one international competition in the six months preceding the study, having gained a podium position in at least one of these competitions. Participants with musculotendinous or osteoarticular injuries and those taking anabolic steroids were not included. Participants who did not attend data collection or did not agree to participate in the study were excluded. However, all excluded participants who were present on the day completed the study as opponents, aiming to increase the effort and intensity of the fighting of the participating athletes. The low number of the sample is justified by the inclusion of very high-level athletes, in a modality where the competitions are eliminatory, thus reducing the number of competitors who reach podiums in major events, a situation already described for other martial arts modalities [Herrera-Valenzuela *et al.* 2019]. In sports competitions where the result is the basis of a selection process, this is inevitable [Faro *et al.* 2020].

The athletes were randomly divided into three groups: control group (CG: the subjects did not ingest CHO) and two experimental groups (GE1: CHO intake immediately before the fight; and GE2: CHO intake 30 minutes before the fight).

Ethics Committee and Registration of clinical trials

Participants were informed about the procedures and objectives of the study and, after agreeing to participate, they signed a consent form. All study procedures were previously approved by the Human Research Ethics Committee of the Federal University of Mato Grosso under number: 2,230,073 and registered at clinicaltrials.gov (NCT03522883).

Experimental Design

The study was carried out at the "Team Base" fight training center, located in the west of Rio de Janeiro. All procedures were performed under standard conditions (temperature: 21-23°C; relative humidity: 40-60%). Participants were instructed not to perform vigorous exercise 24 hours before data collection and to perform an 8-hour fast.

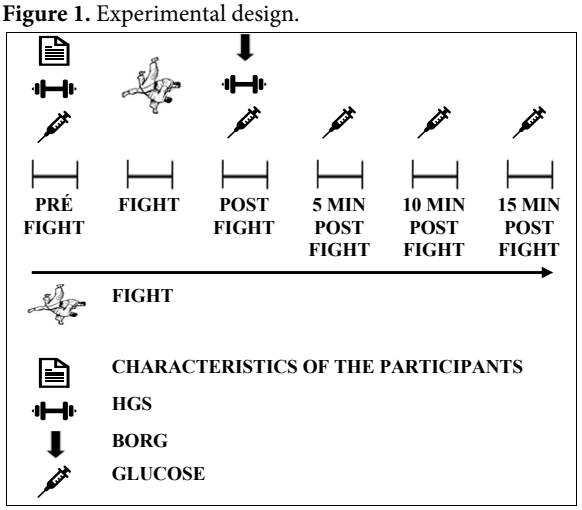
All procedures were performed on one day. Before the study procedures, anthropometric characteristics were evaluated using a scale (GAMA ITALY®) and a portable stadiometer (Sanny®, Personal model) (Table 1). Next, the HGS was measured with a hydraulic manual dynamometer (JAMAR®) at pre and post fight. After the fight, the participants reported their perception of effort on an adapted Borg scale. Glycemia was verified before, after, and 5, 10, and 15 minutes after the fight (Figure 2). An overview of the study is shown in Figure 1.

Table 1. Characteristics of the participants (mean ± SD).

	GC (*n*=4)	GE1 (*n*=4)	GE2 (*n*=4)
Age (years)	25.75±8.34	36.75±4.50	31.75±6.18
Stature (m)	1.78±0.02	1.77±0.06	1.75±0.11
Body mass (kg)	82.92±16.29	84.35±15.58	82.27±0.07
BMI (kg/m²)	26.01±4.94	26.98±5.47	26.71±3.09

CG: Control group; GE1: immediate pre-fight intake; GE2: ingestion 30 minutes pre-fight. SD: Standard deviation; BMI: Body mass index. p <0.05.

Figure 1. Experimental design.



Fights
The fights (*Randori*) started by respecting the stipulated times between the components of the same group. Thus, each fight lasted six minutes, without breaks, where the athletes were instructed to perform dynamic movements and maintain high movement, exchanging the opponent every 3 minutes for rested fighters who did not participate in any intervention or control group, aiming to raise the intensity to the maximum during this period; this model is well used and accepted in the literature [Goncalves *et al*. 2012; Lopes *et al*. 2019].

Carbohydrate Supplementation (CHO)
For the administration of CHO supplementation, the "Exceed energy gel" sachet from the manufacturer "Advanced Nutrition®" was used, with a dose of 30g (1 sachet), containing an energy value of 83 kcal = 349kJ, CHO 21g, sodium 82mg, vitamin C 4.2mg, and vitamin E 0.90mg. The carbohydrate was taken directly from the sachet orally by the athletes.

Hand grip strength (HGS)
The measurement of HGS was performed using the JAMAR® brand hydraulic analog dynamometer (Asimow Engineering®, USA), with an accuracy of 0.5 Kg/f and a maximum capacity of 100 Kg/f. The position suggested by the American Society of Hand Therapists (ASHT) was used [Soares *et al*. 2012], with participants in a sitting position with hips and knees at 90° of flexion, shoulder in adduction, elbow flexed at 90°, and wrist and forearm in a neutral position. Participants were instructed to perform with their greatest possible strength and the peak value was recorded.

Modified Borg scale
The perceived effort was assessed using the adapted BORG Scale [Borg 1982] which consists of an ordinal scale ranging from 6 to 20, where 6 represents none and 20 represents maximum intensity. The perception of effort intensity has been considered an important tool to assess the effectiveness of different methods [Nakamura *et al*. 2005; Bastos *et al*. 2012; Stanley *et al*. 2012; Cook, Beaven 2013]. This type of scale enables subjective measurement of the individual perception of the intensity of the effort made, and associated with other metabolic variables can assist in the discussion of different outcomes [Shephard *et al*. 1996; Cook and Beaven, 2013], presenting validity and reliability in different conditions and constituting an important evaluation tool [Borg 1982]. The following standardized question preceded the application of the scale: "How do you rate the intensity of the exercise performed?".

Glycemia
Venous blood was collected in a tube with potassium fluoride + EDTA K3, to quantify blood glucose in triplicate, with a spectrophotometer pre-fight, post-fight, and 5, 10, and 15 minutes post-fight, with BIOCLIN GLICOSE MONOREAGENTE K082, with colorimetric enzymatic action principle - GOD - PAP (Trinder) where Glucose is oxidized enzymatically by Glucose Oxidase (GOD) according to the following reaction: Glucose + O2 + H2O -GOD ---> Gluconic Acid + H2O2. Hydrogen Peroxide, in the presence of Peroxidase (POD) reacts with 4 - Aminoantipyrine and Phenol, forming a cherry red chromogen whose color intensity is proportional to the Glucose concentration. Calculation was used:

$$\text{Glucose (mg / dL)} = \frac{\text{Sample Absorbance x 100}}{\text{Standard Absorbance}}.$$

As the reaction follows the Lambert-Beer Law, the Calibration Factor can be used.

$$\text{Calibration Factor} = \frac{\text{Standard Concentration (100 mg / dL)}}{\text{Standard Absorbance}}$$

Glucose (mg / dL) = Sample Absorbance x Calibration Factor

Statistical analysis
Mean and standard deviation values were calculated for all variables. The normality of the data was initially analyzed using the Kolmogorov-Smirnov procedure. In addition, the t test was used to compare moments and groups. All statistical analysis assumed a significance level of 5%. The analyses were conducted using the statistical package SPSS (2.0).

Results

Table 2 presents the mean and standard deviation (SD) values for all outcomes related to HGS and the Borg scale. Regarding the findings for the HGS, there were different outcomes. In CG and GE1, HGS did not present significant changes, while in GE2, HGS increased significantly. Significant differences were verified between the groups ($P > 0.05$).

The simulated fight protocol resulted in different perceptions of effort between the groups, with higher values of perceived effort in the CG. The values recorded in GE1 and GE2 were similar. Thus, a statistically significant difference was observed only between the CG values when compared with GE1 and GE2 ($P < 0.05$).

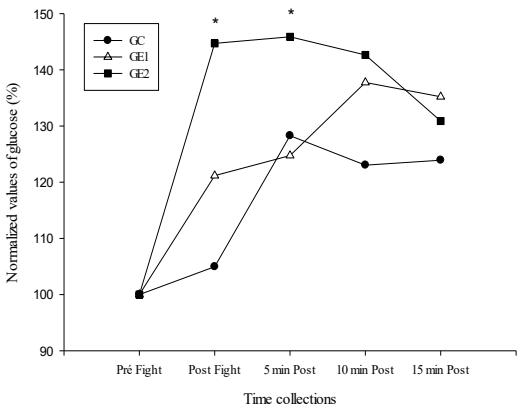
Figure 2 presents the means of the normalized blood glucose data for the three groups and for the five evaluation moments. The GE2 demonstrated a significant difference at moment 2 (post fight) and moment 3 (5 minutes post fight). There were no significant differences in the behavior of GC and GE1.

Table 2. Mean, standard deviation, and *p-value* in the pre and post fight moments, of hand grip strength and perceived effort.

	HGS (Prefight)	HGS (Postfight)	*p-value*	BORG
Control group (GC)	52.00±5.65	51.75±7.93	0.9126	17.25±3.09
Ingestion Just before exertion (GE1)	45.25±4.27	44.75±4.85	0.6042	14±2.00
Ingestion 30 minutes before (GE2)	42.75±9.21	51±7.48	0.0425*	14.5±1.91

Mean and SD values with a 95% confidence interval. p-value> 0.05; HGS: Handgrip strength; BORG: effort perception scale; SD: Standard deviation. * Statistically significant difference.

Figure 2. Blood glucose behavior at different times and groups (%).



* Significant difference in relation to the pre-moment

Discussion

The present study aimed to compare the immediate effects of two supplementation strategies with CHO, on HGS, blood glucose, and perceived exertion intensity, when compared to a control condition.

According to the American College of Sports Medicine [2000], the pre-workout meal should provide sufficient amounts of fluids to maintain hydration, moderate protein to reduce the risk of intolerance, low fat and fiber to facilitate gastric emptying, and relatively high CHO to maximize maintenance of glucose. CHO digestibility is considered an important nutritional property, and its absorption speed in the small intestine determines glycemic and hormonal responses after supplementation [Silva *et al*. 2008].

In the present study, a significant difference in blood glucose values was found only for GE2, with an increase in the post and 5 minutes after the fight in relation to the pre-moment. This suggests that 30 minutes was enough time for carbohydrate absorption, which did not occur for GE1, even though the same supplementation was used. Due to the coordinated action of the hormones insulin and glucagon, blood glucose increases in high-intensity activities, such as BJJ. Some authors claim that excessive insulin release caused by a spike in blood glucose in response to a meal immediately before exercise should be taken into account, which would result in rebound hypoglycemia, that may directly interfere with performance in sports practice [Cyrino, Zucas 1999; Faria *et al*. 2011], which was not observed in the groups. The CG did not present any significant difference in glycemia, suggesting the action of glucagon to maintain glycemia.

For HGS, significantly different values were also found only for GE3, demonstrating that CHO ingested 30 minutes before exercise also increases strength after exercise, which was not verified for the other groups. Previously observed in the literature for activities of extremely prolonged efforts [Cyrino, Zucas 1999; Faria *et al*. 2011], the findings suggest that CHO also proves to be a good strategy for increasing strength performance for athletes in intense and short duration activities, taking into account the absorption time, which according to Cyrino and Zucas [1999] occurs because CHO is the most important energy substrate for muscle contraction, contributing to the increase in glycogen reserve and metabolic homeostasis. There also seems to be a link between glucose and HGS, causing one to increase when the other increases, perhaps due to the availability of glucose in the blood.

The Borg perception of effort scale is already commonly used for BJJ athletes, to estimate the training intensity of fighters, as it is cheap and simple to apply [Amtmann *et al*. 2008; Miarka *et al*. 2020]. The Borg scale showed higher values only for the CG, which suggests that CHO supplementation, regardless of the moment, attenuates the perceived effort. In addition, the literature states that the lower graduation regarding the intensity of the perceived effort demonstrates better recovery, and can assist performance during exercise [Higgins *et al*. 2011; Cook, Beaven 2013]. Thus, the use of nutritional strategies involving the intake of a diet rich in CHO before the practice of intense physical exercises and of short duration deserves special attention, taking into account the absorption time, aiming at greater performance.

The findings of the current study are of particular relevance to the scientific community as they demonstrate outcomes observed in an athletic population little explored by studies. In addition, according to the authors' knowledge to date, this is the first study to address this condition specifically in the population of professional BJJ athletes. Although supplementation intake is a widely addressed topic, few studies demonstrate the effects of different supplementation methodologies of CHO prior

to a BJJ fight, using a study developed based on high methodological quality, with a clinical trial with parallel groups.

A potential limitation of the present study was the sample number. Despite the low number of participants included in the study, it is reiterated that the sample was very specific, and the number of athletes who meet the study inclusion criteria is extremely low. Therefore, additional investigations are suggested that consider the delayed effects on functional, clinical, hematological, biochemical, and metabolic parameters in professional BJJ athletes, as well as for unconventional jiu-jitsu athletes and other fighting schools [Cynarski, Siekanski 2019; Goncalves *et al*. 2020], to enrich the discussion and the scientific basis, as well as studies in which the sample number can be increased, whether using lazar competitors (not so high level) or just BJJ practitioners, as there are few in-depth studies on the sport in question.

Conclusion

Ingestion of CHO before a BJJ fight attenuates subjectively perceived fatigue. In addition, prior CHO intake has been shown to positively influence HGS when ingested 30 minutes prior to exercise, as well as which higher blood glucose values were found for the same assessment moment, suggesting that this time would be sufficient for absorption of CHO by the body, bringing benefits to short and intense physical activities, such as BJJ.

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Wcześniejsze spożycie węglowodanów zwiększa siłę chwytu dłoni i zmniejsza subiektywne postrzeganie wysiłku w czasie walki w brazylijskim jiu-jitsu

Słowa kluczowe: sztuki walki, suplementacja diety, synamometr siły mięśniowej, biochemia, sporty walki

Streszczenie

Tło. Wpływ spożycia węglowodanów (CHO) przed wysiłkiem fizycznym jest już dobrze znany w literaturze, na ogół dotyczy on wpływu ograniczenia spożycia węglowodanów na zdolności fizyczne. Zwraca się uwagę na niedostateczną liczbę badań dotyczących spożycia węglowodanów w różnych momentach i w określonych populacjach. Celem niniejszej pracy była ocena siły chwytu dłoni (HGS), stężenia glukozy we krwi oraz odczuwanego wysiłku u zawodników Brazylijskiego Jiu-Jitsu (BJJ) po spożyciu węglowodanów w różnym czasie.

Materiały i metody. Łącznie w badaniu wzięło udział 12 sportowców, podzielonych na trzy grupy (n=4): Grupa Kontrolna (CG = bez suplementacji); Grupa Eksperymentalna 1 (GE1 = suplementacja bezpośrednio przed walką); oraz Grupa Eksperymentalna 2 (GE2 = suplementacja 30 minut przed walką). HGS mierzono za pomocą hydraulicznego dynamometru analogowego JAMAR® przed i po walce. Glukoza we krwi była mierzona przed, po, 5, 10 i 15 minutach po walce metodą kolorymetryczną przy użyciu spektrofotometru. Postrzeganie intensywności wysiłku weryfikowano za pomocą zaadaptowanej skali Borga.

Wyniki. Istotny wzrost siły chwytu dłoni i stężenia glukozy we krwi pomiędzy poszczególnymi momentami zaobserwowano tylko w grupie kontrolnej GE2. Percepcja wysiłku była większa w grupie kontrolnej CG (bez suplementacji).

Wnioski. Spożycie węglowodanów przed walką w brazylijskim jiu-jitsu wydaje się łagodzić subiektywnie odczuwane zmęczenie i istotnie zwiększać poziom siły chwytu dłoni i glukozy we krwi tylko wtedy, gdy jest spożywane 30 minut przed wysiłkiem.