



# Relation between previous carbohydrate intake and the capillary glycemia of bodybuilders during resistance training sessions

## Relações entre consumo prévio de carboidrato sobre a glicemia capilar de praticantes de musculação durante uma sessão de treino resistido

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### Abstract

The aim of the current study is to evaluate the relation between previous carbohydrate intake and blood glucose behavior in bodybuilders during resistance training sessions. A randomized placebo-controlled study was conducted with 15 participants selected for the experimental group and with 15 ones for the placebo group ( $29 \pm 5$  vs.  $28 \pm 7$  years, respectively,  $p=0.696$ ), who presented physical fitness ranging from acceptable to excellent and were subjected to 10-hour fasting before the training session. The experimental group ingested 250ml of a beverage containing 1g of simple carbohydrate (maltodextrin) per kg of body weight, whereas the placebo group ingested 250 ml of Clight® juice. Capillary glycemia was measured before and after drinking. Subsequently, glycemia was measured every 15 minutes during the training session and after 15-minute recovery. Two-way ANOVA, followed by Tukey post hoc test, was used to analyze the primary outcome. Significance level was set at  $p \leq 0.05$ . The pre-session ingestion of the beverage containing 1g carbohydrate / kg of body weight caused: 1) hyperglycemic state 15 minutes after the ingestion ( $134.53 \text{ mg/dL} \pm 21.02$ ); and 2) maintenance of capillary glycemia at adequate values for 15 min: 118.33; 30 min: 106.60; 45 min: 109.33; and 60 min: 105.27 mg/dL; and at recovery 103.67 mg/dL; however, these values were higher than the ones recorded for the placebo group (pre-session: 85.33; 15 min: 85.40; 30 min: 87.27; 45 min: 90.47; 60 min: 90.60; 15 min recovery: 88.73 mg/dL). Previous carbohydrate intake significantly increased glycemia in the control group, whereas no hypoglycemia was observed in the placebo group. There is no need for individuals to be subjected to supplementation with carbohydrate beverages prior to the training session in order to prevent hypoglycemia.

**Keywords:** Carbohydrate Dehydrogenases. Blood Glucose. Exercise.

## Resumo

Avaliar as relações entre consumo prévio de carboidrato e o comportamento da glicemia durante uma sessão de treino resistido em praticantes de musculação. Estudo randomizado e controlado por placebo. Selecionaram-se 15 indivíduos para o grupo experimental e 15 para o placebo ( $29 \pm 5$  vs.  $28 \pm 7$  anos, respectivamente,  $p=0.696$ ) com condicionamento físico de aceitável a excelente e em jejum de 10 horas. O grupo experimental ingeriu 250 ml de bebida contendo 1g de carboidrato simples (maltodextrina)/kg de peso corporal, e o placebo 250 ml de suco *Clight*®. A glicemia capilar foi medida pré- e pós-ingestão da bebida. Posteriormente, a glicemia foi medida a cada 15 minutos durante o treinamento e após 15 minutos de recuperação. Para análise do desfecho primário, foi utilizada ANOVA *two-way* seguida do *post hoc* de Tukey. Considerou-se significativo  $p \leq 0,05$ . A ingestão da bebida contendo 1g de carboidrato/kg de peso corporal pré-sessão causou: 1) estado hiperglicêmico após 15 minutos da ingestão ( $134,53 \text{ mg/dL} \pm 21,02$ ); e 2) manutenção da glicemia em valores adequados durante a sessão (15 min:  $118,33$ ; 30 min:  $106,60$ ; 45 min:  $109,33$  e 60 min:  $105,27 \text{ mg/dL}$ ) e sua recuperação ( $103,67 \text{ mg/dL}$ ), porém acima dos valores observados no grupo placebo (pré-sessão:  $85,33$ ; 15 min:  $85,40$ ; 30 min:  $87,27$ ; 45 min:  $90,47$ ; 60 min:  $90,60$ ; pós 15 min:  $88,73 \text{ mg/dL}$ ). A ingestão prévia de carboidrato aumentou significativamente a glicemia no grupo controle e não foi observada hipoglicemia no grupo placebo. Para prevenir uma possível hipoglicemia, não há necessidade de o indivíduo suplementar com uma bebida carboidratada antes do treinamento.

**Palavras-chave:** Desidrogenases de Carboidrato. Glicemia. Exercício.

## Introduction

Carbohydrate (CHO) intake before exercising is a good alternative to help keeping the proper functioning of the central nervous system.<sup>1</sup> Such benefit results from improvements in perceptual responses such as discomfort, physical stress and fatigue, as well as from lower probability of developing hypoglycemia.<sup>2</sup> In fact, it assures that important brain areas, such as the motor cortex, remain sufficiently activated to delay the fatigue and to avoid hypoglycemia.<sup>3</sup>

Daily carbohydrate intake is essential for physically-active individuals, thus, it should be planned according to the exercising sessions in order to assure adequate pre- and post-training nutrition. If it is not possible, carbohydrate intake should be adjusted throughout the day, based on individuals' preference and tolerance, in order to assure that their total daily needs are met.<sup>4</sup>

People who exercise in the morning often do it after an 8-10-hour fasting period, when glycogen reserves, mainly the hepatic glycogen ones, are significantly low. Thus, breakfast plays a key role in preventing hypoglycemia during exercising.<sup>5</sup>

The intake of pre-workout CHO can be based on carbohydrate-rich food, preferably three to four hours before the beginning of the training session.<sup>6</sup> However, it is not often possible eating meals within that time frame, which makes the use of rapidly-absorbed CHO supplements useful to maintain glycemia levels and enhance glycogen reserves.<sup>7</sup>

Assumingly, CHO supplementation has some ergogenic benefits such as minimizing the glycogen depletion during strength and resistance exercises in response to elevated glucose levels when resistance training protocols are adopted. On the other hand, reaction time and vital performance-related abilities may be impaired when glucose availability is low.<sup>8</sup>

The effect of taking CHO-containing beverages before exercising on individuals' metabolism and physical performance has been investigated and questioned in the literature. Some studies recorded improved performance,<sup>9,10</sup> whereas others did not find this effect<sup>11,12</sup> or even showed decreased performance.<sup>13,14</sup>

However, the literature remains limited when it comes to experimental studies with better methodological quality about the prior effect of CHO intake on blood glucose behavior during resistance training sessions. Therefore, the aim of the current study was to evaluate the relationship between pre-training carbohydrate intake and blood glucose behavior in bodybuilders throughout a resistance training session, based on a randomized, placebo-controlled experimental design.

## Methodological procedures

We conducted a randomized, placebo-controlled research to evaluate 30 volunteers (16 men and 14 women), who were invited to participate in the study, received explanations about the project and signed the Informed Consent Term (ICT).

The inclusion criteria were individuals (men and women) older than 18 years, subjected to 10-hour fasting, presenting acceptable-to-excellent physical fitness, who were experienced strength training practitioners (i.e., over 1 year of practice) and trained at least three times a week. This group is the one that best represents most individuals who practice this training modality.

The exclusion criteria were individuals with osteomyoarticular issues, clinically diagnosed with insulin resistance, neoplasias, obesity, neurological diseases, pre-diabetes or type 1 and 2 diabetes mellitus, pregnant women and elderly.

The study was approved by the Research Ethics Committee of Centro Universitário UniRedentor (UniRedentor University Center) - Opinion number 2.139.471 - and it met all the criteria set by the National Health Council Resolution 466/2012.<sup>15</sup>

### Carbohydrate and placebo beverage preparation

According to the American College of Sports Medicine,<sup>16</sup> the amount of pre-training CHO to be given to practitioners can be based on their body size and on characteristics of the training session. Therefore, the dosage herein adopted for strength training was 1 g CHO/kg of body weight.

The CHO beverage was prepared with strawberry-flavored Maltodextrin (Fullife®) diluted in 250 ml of water. The placebo beverage was a strawberry-flavored juice (Clight®) that resembled the carbohydrate beverage taste - five drops of sucralose sweetener (Linea®) were added to this beverage in order to make it palatable. It is important mentioning that CHO was not added to the placebo composition.

Both beverages were prepared by the same researcher and volunteers were blind to the content of the beverage they drank.

### Blood glucose evaluation

The instrument used to measure participants' blood glucose was the Accu Check Active portable glucose meter (Roche) with 1 mg/dl accuracy. A drop of blood was collected from one finger of participant's right or left hand with the aid of a lancing device (Roche®). The selected finger was cleaned with cotton soaked in 70% alcohol. The lancing device was used to make a small hole in the volunteer's finger; the first drop of blood was discarded and, then, the blood sample to be analyzed was collected according to the manufacturer's recommendations. It is worth emphasizing that all procedures were based on hygiene and safety protocols, which included the use of latex gloves and disposable puncturing needles.

### Physical training session

Participants were subjected to a resistance training session in the morning, 30 minutes after drinking the pre-training (CHO-added or placebo) beverages.

The strength training session was prepared by two physical education professionals. The selected exercises comprised extensor chair, 45° leg press, thigh extension, plantar flexion, bench press, seated row (pronated grip), shoulder press, pulley triceps, biceps curl and abdominal exercises.

Participants performed three sets of ten repetitions, with one-minute interval between sets and between exercises. The abdominal exercise comprised 20 repetitions performed at the same speed often used by participants in their routine training sessions.

## Evaluating perceived exertion

### *Experimental protocol*

The OMNI-RES scale, adapted by Robertson et al.,<sup>17</sup> was used at the end of the training session to analyze participants' perceived exertion.

Individuals composing the experimental and placebo groups were randomized at the website randomization.com, based on the block allocation method.

A capillary blood sample was collected from all participants, before they drank the pre-training beverages, in order to measure their blood glucose level at rest. Subsequently, participants drank the carbohydrate beverage, or the placebo one and, after 30 minutes, their capillary blood glucose was measured again.

Participants' blood glucose was measured every 15 minutes throughout the training session - each session lasted 60 minutes. Therefore, four blood glucose measurements were taken during the training sessions. Participants were left to rest for 15 minutes at the end of the training session in order to measure their capillary blood glucose at recovery.

It is noteworthy that neither the volunteers nor the capillary blood glucose assessors knew what beverage each participant had ingested.

### *Statistical analysis*

Data were expressed as mean  $\pm$  SD. Student's t-test for independent samples were used to compare the two groups based on age, weight, height and body mass index (BMI). The sex ratio between groups was analyzed through the Chi-square test.

Two-way repeated measures ANOVA was used to analyze the capillary blood glucose behavior at different training times, and it was followed by the Tukey post-hoc test. Significance level was set at 5%. All statistical analyses were performed in the SPSS software, version 20.0.

## Results

The experimental and control groups were similar in age, sex, weight, height and BMI (Table 1). Participants presented the mean body mass index recommended for healthy individuals.<sup>18</sup>

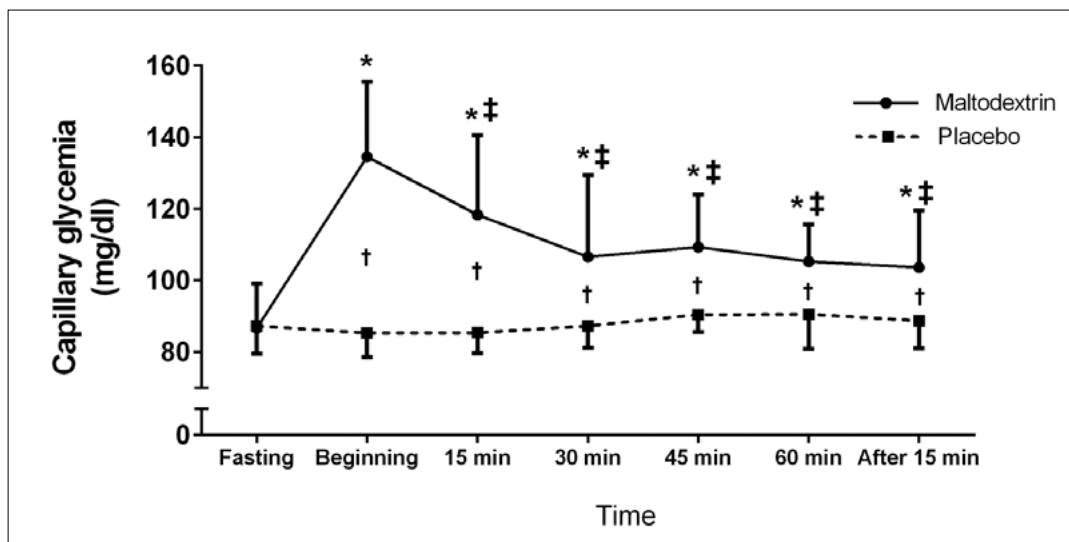
**Table 1.** Characterization of the bodybuilding group living in Carangola-MG, 2017.

Variables	Experimental group (n=15)	Control Group (n=15)	p-value
Age (years)	28.80 ± 5.28	27.93 ± 6.68	0.696
Sex (M/F)	7/8	9/6	0.464
Weight (kg)	69.33 ± 15.86	70.27 ± 11.38	0.854
Height (m)	1.68 ± 0.12	1.72 ± 0.07	0.228
BMI (kg/m <sup>2</sup> )	24.41 ± 5.30	23.38 ± 2.39	0.501

Value = mean ± SD

Thirty-nine percent (39%) of participants had 1 to 2 years of previous experience with strength training; 40.1% of them, more than 2 years; and 20%, more than 5 years training experience.

The intake of carbohydrate beverage before exercising significantly increased participants' capillary blood glucose. The experimental group maintained the capillary blood glucose level significantly higher than that of the control group during the training session (Figure 1). On the other hand, practitioners' perceived exertion was similar between the experimental and control groups ( $4.80 \pm 0.53$  vs.  $5.23 \pm 0.83$ , respectively; p-value: 0.214).



Legend: \* vs. fasting ( $p < 0.05$ ); ‡ vs. placebo ( $p < 0.05$ ); † vs. beginning ( $p < 0.05$ )

**Figure 1.** Blood glucose behavior at rest, before, during and after the training session in the experimental and control groups.

## Discussion

Based on the main results in the current study, the intake of 1g of CHO/kg of body weight before the strength training session caused 1) hyperglycemic state after 30 minutes; and 2) maintenance of capillary blood glucose at adequate levels throughout the training session and at recovery - they were higher than the ones recorded for the placebo group.

Blood glucose results among individuals who ingested 1g CHO/kg of body weight before the training session were similar to the ones found in other studies available in the literature, in which participants presented hyperglycemic response in the first 15 minutes after beverage intake.<sup>12,19-21</sup>

Likewise, Sapata, Fayh & Oliveira<sup>11</sup> have shown that the intake of beverages with different carbohydrate types (simple and complex) and high glycemic index 30 minutes before performing submaximal exercises at second ventilatory threshold did not change participants' performance. This outcome corroborates the studies by Junior & Carvalho<sup>22</sup> and Fontan & Amadio,<sup>23</sup> who found that the intake of different carbohydrate types before exercising did not affect participants' physical performance, regardless of the glycemic index presented by the beverage.

Increased peripheral blood glucose levels lead to increased insulin release after carbohydrate intake.<sup>24</sup> High insulin levels enable glucose uptake by muscles through the translocation of *glucose transporter proteins* (GLUTs), mainly of the type 4 ones, to the surface of muscle fibers.<sup>25</sup> Glucose uptake by muscle cells increases in response to muscle contractions (increase in AMPK and calcium concentrations) when the training starts, so that peripheral glucose uptake remains high, despite the maintenance of, or decrease in, serum insulin concentrations.<sup>26,27</sup>

The placebo group did not show blood glucose oscillations, either due to beverage intake or to exercising. This outcome corroborates other studies in the literature,<sup>12,19-21</sup> in which strength training did not cause significant blood glucose changes during the training session.

Individuals who train during fasting present lower blood glucose and muscle glycogen availability.<sup>28</sup> It may happen due to gradual increase in plasma glucagon concentrations, which leads the hepatic glycogenolysis to increase glucose availability in cells in order to keep them fit to meet the increased metabolic demands generated by the exercise, as well as to increased gluconeogenesis, which is one of the processes adopted by the human body to maintain blood glucose levels during fasting.<sup>29</sup> However, the gluconeogenesis pathway correlates to significant muscle mass and adipose tissue loss when it is associated with prolonged fasting.<sup>11,20</sup>

The years of experience with strength training is another factor that may have contributed to maintain participants' blood glucose during the exercises performed at fasting.<sup>30</sup> In addition, the mean BMI recorded in the current study met the ones found in other studies in the field, in which the investigated population was characterized as eutrophic.<sup>11,19-21,26,31,32</sup>

The decreased blood glucose in the initial period and during the training of the experimental group, in comparison to the 15-minute period of the placebo group, can be attributed to the action of plasma insulin, whose level often increases after CHO intake, which significantly increases blood glucose levels (> 110 mg/dl). Then, glucose is captured by the skeletal muscle through facilitated diffusion, due to GLUT-4 translocation to the surface of the muscle fibers, which, induced by muscle contractions, acts through an insulin-independent mechanism.<sup>33,34</sup>

On the other hand, specific matters - investigated through the analysis of evidences about the need of intaking CHO before training - showed strong evidence that neither the glycemic load nor the glycemic index of CHO-rich meals affected individuals' metabolic results or training performance. In addition, despite the theory behind the metabolic advantages of exercising with little CHO availability in training adaptations, the benefits of such practice to performance outcomes remain unclear, fact that may be related to limitations of few studies available in the literature.<sup>16</sup>



Among the limitations of the present study, it is possible emphasizing the lack cardio-frequency meter, the blood lactate measurement and the sample comprising a specific group, which makes it difficult extending the results to the general population.

## Conclusion

The intake of beverage composed of 1g of CHO/kg of body weight increased the capillary blood glucose values in healthy young individuals with experience in strength training. However, such values remained at adequate levels throughout the training session. In addition, the placebo group did not show clinically significant variation in capillary blood glucose values during the training session.

Therefore, individuals do not need supplementation with carbohydrate beverages before resistance training sessions in order to prevent hypoglycemia.

## Contributors

Lozi BS participated in research conduction, data collection, result interpretation and manuscript writing. Mira PAC, study co-advisor – participated in statistical analyses, result interpretation and critical review until the last version of the manuscript. Quintão DF, study advisor - contributed to the study design and participated in the critical review until the last version of the manuscript.

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