# 48 - GLYCEMIC BEHAVIOR IN RESISTANCE EXERCISE ACCOMPLISHED IN TWO DIFFERENT INTENSITIES

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## INTRODUCTION

The monitoring of metabolic and hormonal behaviors of the organism is an important primary tool in order to understand the responses to physical exercise. Anabolic and catabolic processes induced by exercise can be perceived through the variables such as the cortisone/testosterone relation (Volek et al, 1997), reactive species of oxygen (Molnay, 2006), alteration of the serica concentration of enzymes (Thomas et al, 2000; Hartmann e Mester, 2000), and more recently,markers such as the reactive protein C, and a serica concentration of DNA (Fatouros et al, 2006).

The evaluation of the glycemic behavior is a routine that offers a lot more administrative and financial practicality due to the existence of portable devices and a relatively low cost. Their response to the exercise has been studied a lot in diabetics, but some recent studies have already been applied to healthy athletes.

Our studies have demonstrated that the values of glycemia decrease to those close to those of hypoglycemics in aerobic running exercises of long duration (Silva at al, 2004). However, in monitoring taking place during resistance exercise, the glycemia elevates itself in relation to the resting state (Silva et al, 2006).

This data can indicate that the glycemic behavior is differentiated in aerobic exercises versus anaerobic exercises. However, it is necessary to confirm this premise with methodical models where the same subjects are submitted to exercise with predominately mitocondrial or glycolithic activity.

Thus, the objective of this study was to investigate the glycemic behavior in response to a session of resistance exercise under two conditions, one being with 8 to 10 maximum repetitions, to promote an intense glycolitic activity and the other with the same number of repetitions but with 60% of the weight utilized in the previous session. The tested hypothesis was that in the exercise at a lower intensity, the glycemia would be maintained at lower levels, confirming the premise that the glycemia elevates itself in exercise with more intense anaerobic activity.

## METHODOLOGY

It's about a study of an experimental type and transverse character. It was accomplished with a population of subjects of the male sex, who practice weight lifting. Five subjects were chosen that met the criteria to have between 18 and 25 years of age, to have been practicing weight lifting for at least six months, to constantly keep up with the trainings and perform exercises for inferior members for at least two times per week, using minimally the following exercises: leg press at 45 degrees, leg extensions, leg curls, calves and squats.

The selection of the participating subjects was made by convenience , in two gyms in the city. The researchers performed tests with the purpose of finding subjects that fit the inclusion criteria of the study, those that came accomplishing the trainings with 8 to 10 maximum repetitions.

In order to fulfill this criteria, the researchers observed the subjects' weight and velocity of execution in their habitual trainings. In the following session, the subjects were requested in the first set of each exercise for inferior members to perform the maximum possible number of repetitions until error occurs, using the weight and velocity of habitual executions. Those who accomplished between 8 and 12 repetitions in this procedure were classified as able to participate in the study.

Each subject considered apt was invited to be integrated in the study were given an explication of the objectives and the procedures that must be met. Those that agreed with the participation were asked to sign a term of free compliance and clarification, resolution conforms 196/96, from the ministry of health.

In order to evaluate the glycemia, a portable glycometric device of the brand Roche, model Acucheck was used, which utilizes enzymatic reagents and colormetric to determine the concentration of substrates in the blood. In order to acquire this drop of blood, a puncture device, also from the brand Roche, was used which rendered the process practically painless and guaranteed the procedure hygienic.

The collection of data consisted of glycemic measurements in two situations of resistance exercise, one being with 8 to 12 RM's (G1) and the other with the same number of repetitions, but with the weight equivalent to 60% of the previous session (G1).

For the procedure G1, the subjects had a glycemia measurement at the moment they arrived for the procedure (PRL). After, they consumed a snack consisting of 25g of carbohydrates and glycemic index of 56, and had a glycemia measurement thirty minutes after this snack (POL).

Immediately following, a training session consisting of three sets of 8 to 12 maximum repetitions was performed with ten exercises on five machines in the following order: Leg extension, leg press at 45 degrees, leg curls, squats and calves. They made the five first exercises in this order and after the last machine, they repeated the exercises in the same sequence. The resting interval was 1 minute and 30 seconds between the sets and two minutes between the exercises. The velocity of the execution was equal to what was already habitually practiced.

Immediately at the end of the third set of the $2^{nd}$, $4^{th}$, $6^{th}$, $8^{th}$ and $10^{th}$ exercise, a drop of blood was taken in order to measure the glycemia. For this, the subject continued on the machine at the end of the third set, while the researchers made a cleaning of the finger a cotton ball embedded with 70% alcohol and quickly dried with another dry cotton ball. After this, a puncture device was used to obtain the drops of blood.

After 48 hours, the G2 situation was performed. For this, all of the procedures of G1 were repeated, with a variation in that the exercises were performed with weights equivalent to 60% of the weight used in G1. The order of the exercises, velocity of execution, the number of sets and intervals stayed constant. Also the blood collections occurred at the same times.

The subjects were instructed to not perform physical exercise and to not consume any nutritional supplements on the day of the collection. The two trainings were proceeded by a five minute session of stretching. Before the start of the first set of the first exercise, in G1 as well as in G2, the subjects performed 15 to 20 repetitions with a weight that they considered to be low, as a form of warm-up.

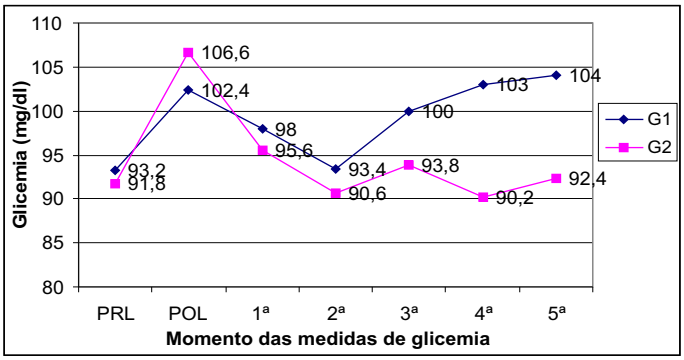
For the analysis of the date, descriptive statistics were used. The average glycemics of each of the measurements (before ad after the the snack, and the five measurements during the exercises) were plotted on a line graphin order to compare the glycemic behavior in the two procedures. The Wilcoxon test was used to test the differences between the glycemic behavior in the procedures G1 and G2.

## RESULTS

In the two collection days of data, th subjects arrived with similar average glycemic values (93,2 and 91,8 mg/dl for G1 and G2 respectively, wit p=0,715). The measurements taken after the snack and immediately before the start of the training revealed glycemias of 102,4 mg/dl for G1 and 106,60 for G2 (p=0,500). This showed that in the two procedures, the subjects began the exercise with similar glycemic states.

The graph 1 presents the glycemic behavior during the procedures G1 and G2. In the two first measurements during the training, a decrease in glycemia was observed in G1, as well as in G2. It was noticed that from the third measurement onwards, the behavior was practically the opposite, with the higher intensity (G1) promoting elevation of Glycemia, while in the less intense training, the glycemia remained practically at the same values since they had fallen at the beginning of the training.

Also, it can be pointed out that during all of the procedure, the average glycemia of G1 was higher than that of G2. The statistic test revealed that this difference became significant as the end of training was reached (p=0,893; 0,588; 0,138; 0,043 and 0,043, respectively for the 1st, 2nd, 3rd, 4th an 5th measurements taken during the training.




Graph 1: Average glycemia at the time that the subjects arrived for the procedure (PRL), 30 minutes after the snack (POL), and in the five measurements taken during the exercise.

**DISCUSSION**

The data presented here collaborates with information of previous studies that show that the glycemia has a rapid fall at the beginning of exercise (Silva et al, 2006; Silva et al, 2004; Foss et al, 1993; Tsuji et al, 1993). It can be noted that these behaviors showed similarities despite having been used in different types of exercises

Also, it had been demonstrated that in resistance exercise, glycemia does not have an accentuated fall (Silva et all, 2006), which on the contrary, occurs in aerobic exercise (Silva et al, 2004). The present study shows the methodical advantage of taking place with the same subjects performing the same type of exercise, with the variation only in the intensity of the exercise as the differentiating variable.

Our hypothesis that the intensity, more than the type, would be the determining factor for the differences in the glycemic behavior in response to exercise. This hypothesis was confirmed with a demonstration of a higher seric concentration of glucose in response to exercise at a higher intensity.

In order to explain this difference, it was enforced with another hypothesis that the higher glycolithic activity in exercises at high intensity is responsible for this difference (Tirapegui, 2006). For this mechanism, the pirovato produced in high concentration, as a result of glucolise, reacts with the hydrogen proteins (Brooks, 2001; Robergs, 2001). This induces a high production of lactate, which upon leaving the cells of the muscle, one of its parts going to the liver where occurs gluconeogenesis.

There are still necessary studies that confirm this relation between the production of lactate and glycemia. The repetition of the of the same methodology of this study, adding to the collections of concomitantly lactate to the seric glucose in two distinct intensities, confirm that the high glycemia comes from a high gluconeogenesis having the lactate as substrate.

In the meantime, the hormonal participation in this glycemic behavior still needs to be investigated, since the neoglucogenesis could be using the glycerol originating from the breakage of triglycerides a a sunstrate, that can also occur during the force of exercise. Besides this, a greater or lesser secretion of glucagon could have a strong influence on the peripherical captivation of glucose and consequently, the glycemia, during exercise.

Therefore, the data of this study are significantly important not only to call attention to the intensity of the exercise as the determining factor in the glycemic behavior, but also to show that there is still a lot to be studied about the endocrine aspects and metabolics that can justify these differences of glycemic behavior in exercise.

**CONCLUSION**

The data of this study demonstrated that the intensity of exercise is a determining factor in glycemic behavior in resistance exercise, with higher intensities being promoters of higher glycemic levels. Even so, the high production of lactate in high intensity exercises must be the explaining mechanism for this phenomenon, the activities of some hormones deserve to be studied, but also it is still necessary to study the correlation between glycemia and lactate.

**REFERENCES**

BROOKS, GA. Lactate doesn´t necessarily cause fatigue: o why are we surprised. **Journal of physiology**. 2001; 536:1.

FATOUROS IG, DESTOUNI A, MARGONIS K, JAMURTAS AZ, VRETTOU C, KOURETAS D, MASTORAKOS G, TAXILDARIS K, KANAVAKIS E, PAPASSOTIRIOU I. Cell-Free Plasma DNA as a Novel Marker of Aseptic Inflammation Severity Related to Exercise Overtraining**.** ***Clin Chem.*** 2006; 13: [Epub ahead of print].

FOSS MC, CUNNINGHAN LN, AOKI TT. Estudo do comportamento metabólico de indivíduos normais em exercício físico moderado. **Arquivos brasileiros de endocrinologia** e metabologia. 1993; 37 (04): 211 - 16.

HARTMANN U, MESTER J.Training and overtraining markers in selected sport events. **Med Sci Sports Exerc**. 2000 Jan;32(1):209-15.

KRUSTRUP P, MOHR M, STEENSBERG A, BENCKE J, KJAER M, BANGSBO J. Muscle and blood metabolites during a soccer game: implications for sprint performance. ***Med Sci Sports Exerc.*** 2006; 38(6).

MOLNAR AM, SERVAIS S, GUICHARDANT M, LAGARDE M, MACEDO DV,SILVA LP, SIBILLE B, FAVIER R. Mitochondrial H2O2 production is reduced with acute and chronic eccentric exercise in rat skeletal muscle**.** ***Antioxid Redox Signal***. 2006;8(3-4):548-58.

ROBERGS RA. Exercise-induced metabolic acidosis: Where to the protons come from. **Sportscience**; 2001. 5 (2). Disponível em sportsci.org/jour/0102/rar.htm. Acesso em 23.12.2003.

SILVA AS, SILVA, OFA, SILVA, JMFL. Glycaemic behaviour within resitance exercises in diferente moments after ingesting cabohydrates. ***FIEP Buletin***. 2006; 76(special edition): 392-5.

SILVA AS, PEREIRA VA, PEREIRA PA, ARAÚJO IML, ATAÍDE DMS. Resposta glicêmica a um treinamento de endurance de longa duração com e sem suplementação de carboidratos. In. **Anais do VI simpósio nordestino de atividade física & saúde**, Recife-PE, 2004.

THOMAS SJ, COONEY TE, THOMAS DJ.Comparison of exertional indices following moderate training in collegiate athletes. **J Sports Med Phys Fitness**. 2000; 40(2):156-61.

TIRAPEGUI, J.; **Nutrição, Metabolismo e Suplementação na Atividade Física.** São Paulo: Atheneu, 2005.
TSUJI, H.; CURI, P.R.; BURINE, R.C. Alterações metabólicas e hormonais em nadadores durante o treinamento físico. **Rev. Bras. Ciênc. Mov**., 1993; 7 (02): 35 - 41.
VOLEK JS, KRAEMER WJ, BUSH JA, INCLEDON T, BOETES M. Testosterone and cortisol in relationship to dietary nutrients and resistance exercise.. **J Appl Physiol**. 1997 Jan;82(1):49-54.

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**GLYCEMIC BEHAVIOR IN RESISTANCE EXERCISE ACCOMPLISHED IN TWO DIFFERENT INTENSITIES**

**SUMMARY**

The object of this study was to investigate the behavior of glycemia in response to two sessions of resistance exercise, accomplished using two distinct intensities. Participating in this study were five men who were practicing veterans of this type of exercise, with ages between 19 and 25 years. They participated in two sets of exercise, one being three series of 8 to 10 maximum repetitions, with a rest of 1.5 minutes between the series, in 10 exercises for inferior members (G1), the other set with the same characteristics, but with only 60% of the weight of the previous set (G2). They had a glycemia measurement after at least three hours without eating and then consuming a snack consisting of 25g of carbohydrates and a glycemic index of 56. Thirty minutes after this snack, the glycemia was measured again, and soon after, they began the training session. Five new glycemic measurements were taken after every two exercises during the two sets. The instrument utilized was a portable glycosimetro, model Acucheck Advantage from the brand Roche. The data was treated discreetly and the differences between the averages of G1 and G2 were analyzed by means of the Wilcoxon test, for $p<0,05$. It can be observed that the glycemia decreased at the beginning of the exercise for G1 and G2, and afterwards, the values remained relatively the same for G2, but increased for G1 (98; 93,4; 100 e 104 mg/dl for G1 and 95,6; 90,6; 93,8; 90,2 e 92,4 mg/dl for G2). The glycemic values were always higher for G1 with statistic differences found in the last two measurements (0,04). It can be concluded that the intensity of the resistant exercise interfered in the glycemic behavior, with the highest serica concentration of glucose occurring in the most intense exercise.

**Key words:** Resistance exercise, glycemia, energetic predominance

**COMPORTEMENT GLYCÉMIQUE AUX EXERCICES RESISTÉ REALISÉ À DEUX INTENSITÉE DIFFERENTES.**

**RESUMÉ**

Ces études realisé vise enquérir le comportement de la glycémic em réponse à sessions d'exercices resiste, realisé avec deux intensitées distintes. Au l'étude a été participé 5 hommes praticants vétérants de cette modalité d'exercices, evirons 19 et 25 agée. Ils se sont realisé deux sessions d'exercices,eyant une avec trois séries de 08 a 12 repetions maximum, se basent au intervslle de 1,5 minutes pendant les séries, em 10 exercices au membres inferieurs (G1), autres session avec memes caractheristiques pourtant charge appliqueés seulment 60% de la session anterieur (G2). Ils s'out soumis pour leur aquérir lês glycimes mésurer après anvirons gheurs pás alimentation subséquentement ils ont pris um goûter base avec 25g de carboidrates et l'index glycemic de 56. Trinte munutes après la collation la glycémie a eté mésurer une fois plus, après ça s'est comencéé la session d'entrâiment. Cinque neuves mesures glycemiques out été realisée pardeux exercices respectivement. Pendant la sessions l'appareil utilisé est glicosimeter portable modèle Acuchec Advantage, A de la marque Roche. Les informations ont été traiter discritivement et differences parmi lês moyennes de G1 e G2 ont été realisée moyennent test de wiloxom, pour $p = 0,05$. S'a verifié que la glycémie asoubi une chute au debout d'exercice pour G1 e G2 um sequénce cets valeur ici se maintenait dans G2 pourtant ont souffrit hausse G1 (98; 93,4; 100,103 e 104 mg/dl pour G1 e 95,6; 90,6; 93,8; 90,2 e 92,4 mg/dl pour G2). Les valeurs glycemiques ont été toujours plusfort pour G1, avec variations statistiques daus les deux dernières mésure (0,04). On concluit que l'intensité d'exercices resisté interfere sur comportament glycemique,avec majeur concentration seric de glycose succédant dans l'exercices plus intense.

**Le mots rélevants**: exercices resiste, glycemie, predominance energétique.

**COMPORTAMIENTO GLICÊMICO EN EL EJERCICIO RESISTIDO REALIZADO EN DOS INTENSIDADES DIFERENTES.**

**RESUMEN**

El objetivo de este estudio fue investigar el comportamiento de la glicemia en respuesta a dos sesiones de ejercicio resistido, realizado con dos intensidades distintas. Participaron del estudio cinco hombres practicantes veteranos de esta modalidad de ejercicio, con edades entre 19 25 años. Realizaron dos sesiones de ejercicio, siendo una con tres series de 08 a 12 repeticiones máximas, con intervalo de 1,5 minutos entre las series, en 10 ejercicios para miembros inferiores (G1), otra sesión con las mismas características, pero cargas de apenas 60% de la sesión anterior (G2). Tuvieron la glicemia medida después de por lo menos tres horas sin se alimentar y enseguida ingirieron una merienda basada con 25 g de carbohidratos y índice glicérico de 56. Treinta minutos después de esta merienda, la glicemia fue medida nuevamente, y después de ellos iniciaron la sesión de entrenamiento. Cinco nuevas medidas glicéricas fueron realizadas cada dos ejercicios durante las dos sesiones. El instrumento utilizado fue un glicosímetro portátil, modelo Acucheck Advantage, de la marca Roche. Los datos fueron tratados descriptivamente y diferencias entre las medias de G1 y G2 fueron analizadas por medio de la prueba de Wilcoxon, para $p=0,05$. Se observó que la glicemia sufrió caída en el inicio del ejercicio para G1 y G2, y enseguida estos valores se mantuvieron en G2, pero sufrieron aumento en G1 (98; 93,4; 100, 103 104 mg/dl para G1 y 95,6; 90,6; 93,8; 90,2 92,4 mg/dl para G2). Los valores glicéricos fueron siempre mayores para G1, con diferencias estadísticas siendo encontradas en las dos últimas medidas (0,04). Se concluye que la intensidad del ejercicio resistido interfiere en el comportamiento glicérico, con mayor concentración sérica de glucosa ocurriendo en el ejercicio más intenso.

**Palabras - llave**: Ejercicio resistido, glicemia, predominancia energética.

**COMPORTAMENTO GLICÊMICO NO EXERCÍCIO RESISTIDO REALIZADO EM DUAS INTENSIDADES DIFERENTES.**

**RESUMO**

O objetivo deste estudo foi investigar o comportamento da glicemia em resposta a duas sessões de exercício resistido, realizado com duas intensidades distintas. Participaram do estudo cinco homens praticantes veteranos desta modalidade de exercício, com idades entre 19 e 25 anos. Eles realizaram duas sessões de exercício, sendo uma com três séries de 08 a 12 repetições máximas, com intervalo de 1,5 minutos entre as séries, em 10 exercícios para membros inferiores (G1), outra sessão com as mesmas características, mas cargas de apenas 60% da sessão anterior (G2). Eles tiveram a glicemia medida após pelo menos três horas sem se alimentar e em seguida ingeriram um lanche baseado com 25 g de carboidratos e índice glicêmico de 56. Trinta minutos após este lanche, a glicemia foi medida novamente, e logo após eles iniciaram a sessão de treinamento. Cinco novas medidas glicêmicas foram realizadas a cada dois exercícios durante as duas sessões. O instrumento utilizado foi um glicosímetro portátil, modelo Acucheck Advantage, da marca Roche. Os dados foram tratados descritivamente e diferenças entre as médias de G1 e G2 foram analisadas por meio do teste de Wilcoxon, para $p=0,05$. Observou-se que a glicemia sofreu queda no início do exercício para G1 e G2, e em seguida estes valores se mantiveram em G2, mas sofreram aumento em G1 (98; 93,4; 100, 103 e 104 mg/dl para G1 e 95,6; 90,6; 93,8; 90,2 e 92,4 mg/dl para G2). Os valores glicêmicos foram sempre maiores para G1, com diferenças estatísticas sendo encontradas nas duas últimas medidas (0,04). Conclui-se que a intensidade do exercício resistido interfere no comportamento glicêmico, com maior concentração sérica de glicose ocorrendo no exercício mais intenso.

**Palavras - chave**: Exercício resitido, glicemia, predominância energética.