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Cardiovascular Exercise in the Fasted State in Healthy Young Adults: Analysis of the Glycemic Profile

Exercício Cardiovascular em Adultos Jovens Saudáveis: Análise do Perfil Glicémico

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Abstract

Introduction: Exercise is beneficial for health and reduces cardiovascular disease and all-cause mortality. An increasing number of recreational and elite athletes practice exercise in the fasted state with the purpose of improving its benefits and performance. However, there is no consensus regarding the effects of feeding patterns and its results.
Objective: To evaluate the effect of fasting in the glycemic profile during exercise.
Methods: A group of five healthy recreational athletes between 23 and 29 years old completed a total of twenty-three trials of 45 minutes of continuous moderate intensity cardiovascular exercise in a static bicycle, twelve of which in the fasted state and the rest postprandial, after a small meal. Glucose monitoring was done with Abbott FreeStyle Libre®. Statistical analysis was made using Mann-Whitney test and p-value <0.05 was considered statistically significant.
Results: Glucose levels remained stable throughout the sessions in the fasted state, but dropped 12.7% (0.89mmol/L) in the first 30min of the post-prandial sessions, stabilizing from then on.
Conclusions: Fasted state continuous moderate intensity exercise proved to be safe, with no hypoglycemia and a significantly inferior glucose lowering effect (compared with postprandial exercise), being the first time it was demonstrated with glucose monitoring every 5 minutes.

Keywords: cardiovascular exercise, fasted state, healthy young adults, glycemia, glycemic profile, Abbott FreeStyle Libre®, flash glucose monitoring

Resumo

Introdução: O exercício é benéfico para a saúde e reduz a mortalidade cardiovascular e global. Um número crescente de desportistas recreativos e de elite praticam exercício em jejum com o objectivo de incrementar os seus benefícios e a *performance*. No entanto, não existe consenso quanto aos efeitos dos padrões alimentares e os seus resultados.
Objectivo: Avaliar o efeito do jejum no perfil glicémico durante o exercício.
Métodos: Um grupo de cinco praticantes desportivos regulares, saudáveis com idade entre os 23 e os 29 anos completou um total de vinte e três sessões de 45 minutos de exercício cardiovascular contínuo de intensidade moderada em bicicleta estática, doze dos quais em jejum e os restantes pós-prandiais, após uma refeição ligeira. A monitorização dos níveis de glucose foi efectuada com recurso ao sistema *Abbott FreeStyle Libre*®. A análise estatística foi efectuada utilizando o teste Mann-Whitney e um valor p <0,05 foi considerado estatisticamente significativo.
Resultados: Os níveis de glucose mantiveram-se estáveis ao longo das sessões em jejum, mas diminuíram 12,7% (16mg/dL) nos primeiros 30min das sessões pós-prandiais, estabilizando a partir daí.
Conclusões: O exercício contínuo de intensidade moderada em jejum mostrou ser seguro, sem ocorrência de hipoglicémias e com uma significativamente menor descida glicémica (comparativamente ao exercício pós-prandial), sendo a primeira vez que tal é demonstrado com monitorização da glicose a cada 5 minutos.

Palavras-chave: exercício cardiovascular, jejum, adultos jovens saudáveis, glicémia, perfil glicémico, *Abbott FreeStyle Libre*®, monitorização flash da glucose

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> INTRODUCTION

Exercise is known to have major beneficial effects on health, including decreased cardiovascular disease and all-cause mortality. [1]
An increasing number of recreational and elite athletes is now utilizing exercise in the fasted state with the purpose of improving consumption of fat as a substrate, [2,3] maximal aerobic capacity, [4] oral glucose tolerance, insulin sensitivity and muscle capacity for transporting and oxidizing fat. [5,6]
In healthy individuals, exercise suppresses insulin secretion, resulting in increased hepatic production of glucose, lipolysis and reduced peripheral glucose uptake. [7]
Vigorous activity is also associated with a rise in catecholamines, cortisol and growth hormone, and may result in hyperglycemia. [8]
Although there are now some studies that show stable glucose levels during endurance exercise in the fasted state, [9] there is still no universal consensus regarding the effects of feeding patterns and its results. [10]

> METHODS

Participants: Healthy and recreational athletes, volunteers, with ages between 18 and 35 years old and body mass index (BMI) between 18.5 and 25kg/m^2, recruited between February and July 2017. The protocol was approved by the local Ethics Committee and all participants signed written consent forms.
Experimental design: Each participant was proposed to completed six trials of continuous moderate intensity cardiovascular exercise (defined as 64-76% of the maximum estimated heart rate), in a static bicycle, with 45 minutes duration, three of which in a fasted state and the other three postprandial (30 minutes after a meal of approximately 480cal/2009kJ), in a randomized order. During the trials, only water consumption was allowed, restriction that was extended to the 10 hours before every fasted state trial. In the 30 minutes that followed each session, a similar meal took place. Trials for each participant were performed under similar conditions and within 2 weeks.
Glucose monitoring: Participants used a last generation flash glucose monitoring system (Abbott FreeStyle Libre®), consisting of a small disposable sensor inserted into the skin that measures glucose in the interstitial fluid, estimating its blood concentration with high accuracy [11]. Glucose levels were registered every 5 minutes during exercise sessions and every 15 minutes in the 8 hours following the exercise.
Statistical analysis: Collected data was analyzed using SPSS software version 21.0. Glucose level variations during fasted and postprandial exercise were analyzed using Mann-Whitney test. A significance level of 5% was used.

> RESULTS

Participants: The group of volunteers was constituted of three males and two females, all healthy and recreational athletes, with ages between 23 and 29 years old (median 29, interquartile range 3), non-smokers and non-steroid users, with BMI between 21 and 24kg/m^2 (median 22.5, interquartile range 1.5). Twenty-three exercise trials, twelve of which in the fasted state, were performed, with all participants performing at least one exercise session while fasting and another postprandial. All exercise trials were analyzed, comparing fasted state with postprandial.
Pre-test evaluation: In the beginning of the exercise sessions, glucose levels were similar weather volunteers were fasting or not (p>0.05) (Table I).

Table I - Glucose levels (mmol/L) at the beginning of the exercise sessions.

	Fasted state	Postprandial
Median*	5.94	5.77
First quartile (Q1)	5.81	5.49
Third quartile (Q3)	6.16	6.58
Minimum	3.39	3.94
Maximum	6.72	8.99

*p-value >0.05

Variation during exercise: Analyzing the variation during the exercise sessions, it was noticed that while glucose levels remained stable throughout the sessions performed in the fasted state, these levels dropped in the first 30 minutes of the postprandial sessions, stabilizing from then on (Figures 1 and 2 and Table II).
The median glucose drop in the first 30 minutes of postprandial exercise sessions was 12.7% [0.89mmol/L]. Comparing these results with exercise sessions in the fasted state, we find the difference is statistically significant at 25 (p=0.042) and 30 minutes (p=0.023) (Table II). By the end of the sessions, postprandial exercise had a higher glucose lowering effect than fasted state (p>0.05) (Table III).

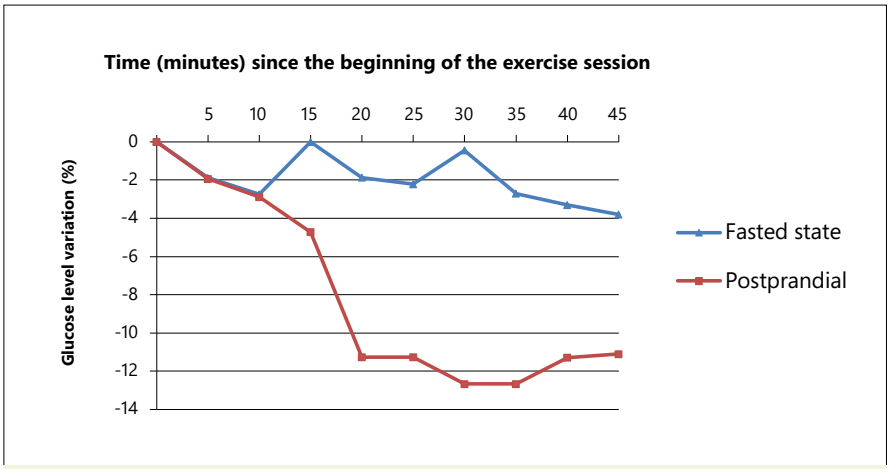

Figure 1 - Glucose variation (%) during exercise sessions.

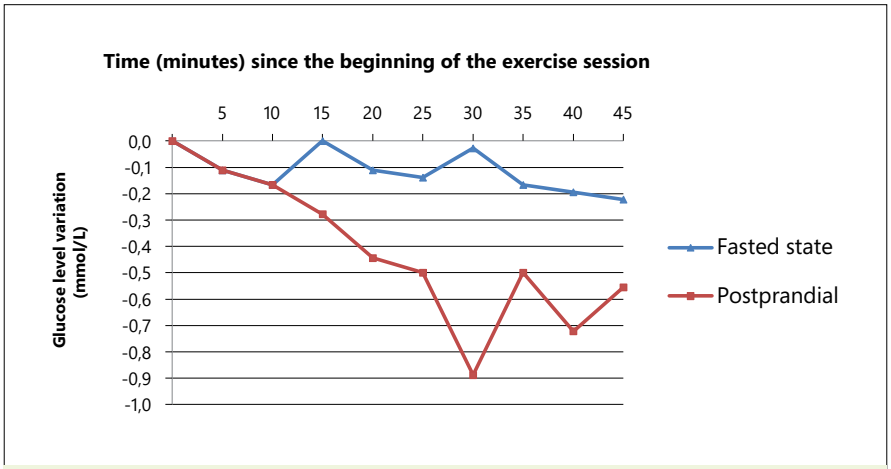

Figure 2 - Glucose variation (mmol/L) during exercise sessions.

Table II - Glucose levels (mmol/L) after 30 minutes of exercise.

	Fasted state	Postprandial
Median*	5.99	5.66
First quartile (Q1)	5.22	4.47
Third quartile (Q3)	6.17	6.35
Minimum	3.61	3.27
Maximum	6.60	7.94

*p-value <0.05

No hypoglycemia (<2.8mmol/L) was detected throughout the exercise sessions.

After the exercise: Two hours after the end of the exercise sessions, glucose levels returned to values similar to the beginning, with a slight increase in the postprandial exercise ($p>0.05$) (Table IV).

No hypoglycemia (<2.8mmol/L) was detected in the 8 hours following the sessions.

> DISCUSSION

The recruited volunteers constituted a heterogeneous group, including males and females from different ages, but all young healthy adults with regular exercise habits and not regular practitioners of fasted state exercise.

Although all volunteers were proposed to perform six exercise sessions, only two of them met that objective completely. Nevertheless, all participants performed at least one exercise session while fasting and another postprandial and the final number of sessions was almost symmetrically divided. The failure in the other cases was due to flash glucose monitoring sensor malfunction, namely detachment from skin invalidating further accurate readings. That is a possible event with these kind of devices, made more common with exercise and hot weather, because of increased sweating.

Glucose values at the beginning of the exercise sessions were not surprising considering that participants were all healthy. However, in the postprandial exercise sessions, in order to compensate the additional amount of glucose made available from the prior meal, insulin levels must be increased at the same time. This could explain the significant drop verified in the glucose levels during the first 30 minutes of postprandial exercise, with circulating insulin producing its effects and increasing glucose transport from the blood to the cells. The stabilization after that point is probably due to other compensatory mechanisms, namely hormonal, also responsible for the differences verified in the two hours after the end of the exercise.

Despite the limited sample used, with only healthy subjects, we were able to prove that fasted state continuous moderate intensity exercise is safe, with no hypoglycemia detected, even in individuals not used to practice exercise in the fasted state. We also demonstrated the significantly inferior glucose lowering effect (comparing with post-

Table III - Glucose levels (mmol/L) at the end of the exercise sessions.

	Fasted state	Postprandial
Median*	5.74	5.38
First quartile (Q1)	5.01	4.69
Third quartile (Q3)	5.99	6.41
Minimum	3.55	3.16
Maximum	7.16	8.55

*p-value >0.05

Table IV - Glucose levels (mmol/L) 2 hours after the end of the exercise sessions.

	Fasted state	Postprandial
Median*	5.99	6.11
First quartile (Q1)	5.63	5.83
Third quartile (Q3)	6.35	6.38
Minimum	3.61	4.16
Maximum	7.49	7.55

*p-value >0.05

prandial exercise), with stable glucose levels at least during the first 45 minutes. To the best of our knowledge, this is the first time it was demonstrated with glucose monitoring every 5 minutes. It's also valuable the elaboration of a simple and feasible protocol and the experimentation of new devices in this particular condition (exercise). Further study is warranted in a longer-term trial with a greater number of participants and on special populations. The same team is currently applying a similar protocol to a population of type 2 diabetics with ischemic cardiopathy, with promising preliminary results. <

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Conflicts of interest:
None to declare.
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