

# Comparison between Preexercise Meals Intake Effect with Different Glycemic Load on Exercise Performance in Female Athletes

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**Abstract** Athletes usually search for strategies to optimize their performance. Manipulation of carbohydrate (CHO) resources glycemic load in order to optimizing athletic performance provides new research areas in nutritional sport. Purpose of this study is to examine the effects of two isocaloric meals with different glycemic load (GL) on exercise performance and serum free fatty acids. Thirty six non-professional athletic women with ages between 19 and 24 were assigned in a double blinded randomized clinical trial with two period cross-over design. Participants in each group received a high or low GL meal as a breakfast, and 7-day wash out period is determined. serum free fatty acid (FFA) measurements were performed before and after each phase of intervention. 3 hour After ingestion of a meal, participants run to exhaustion, in a 20 meters shuttle run pacer. Time to exhaustion (TTE) was recorded as a measure of exercise performance. In an attempt to ensure that subjects run to exhaustion, rating of perceived exertion (RPE) was measured, using a Borg scale, too. The ingestion of a low GL or high GL pre-exercise meal did not lead to different TEE and RPE at 3 hours before exercise in female athletic students. Mean changes of serum FFA were higher in low GL than high GL meal. Consumption of a low GL meal compared with a high GL meal at 3-hr before a shuttle run pacer, was not associated with significant changes in TEE and RPE levels but low GL meal led to more increase serum FFA than high GL.

**Keywords:** glycemic load, glycemic index, pre-exercise meal, exercise performance, metabolism

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## 1. Introduction

Athletes usually search for strategies to optimize their performance [1]. Glycogen content of muscles decreases during exercise programs and if glycogen depletes, athletes won't be able to continue their exercise plan [2,3]. Several studies report that adherence to a carbohydrate-restricted diet can improve athletes' performance, because it can lead to greater fat oxidation and glycogen-sparing effects during exercises [3,4,5]. However other studies indicated consuming high carbohydrate (CHO) diet before exercise enhances subsequent endurance exercise performance [6] and reduces rating of perceived exertion (RPE), especially in high intensive exercises [2,7]. The concept of the glycemic index (GI) is to classify foods based on their actual postprandial blood glucose or white

bread [8]. In addition to the beneficial effects of low GI (LGI) foods in controlling blood glucose levels; these days, useful roles of these foods find wider applications such as athletics' performance [9]. Manipulation of GI from different sources of CHO in order to optimizing athletic performance has been investigated in different studies [8,10]. Researches show that a CHO-rich meal with LGI level is a suitable choice before prolonged exercises plan, because it causes blood glucose being more stable and maintains free fatty acids (FFA) at higher levels during exercises [11,12]. With regards to this point that increasing fat availability during exercise enhances the capacity of trained individuals to perform prolonged exercise [13]. Wong et al. investigated the effects of consuming the foods with low or high GI (HGI) at 2 hours prior to endurance running. They observed that participants' run time was higher after intaking LGI foods than the mentioned time after HGI foods; and the end of

the exercise, serum FFA concentrations were higher after LGI than HGI meal [11]. There are some studies in support of these beneficial effects [14,15], however several studies found no different effect in TTE of athletes [16,17,18]. A study by Jamurtas and colleagues showed that ingestion of foods with LGI or HGI at 30 minutes prior to one-hour cycling did not show any significant changes in TTE values [16]. The GI indicates only the type of carbohydrate, ignoring the total amount of CHO in a typical meal. Although, both the type and amount of CHO influence the postprandial glycemic and insulin response which affects muscle glycogen supply and improving athletes' exercise performance [19]. Glycemic load (GL) of a serving of food can be calculated as its CHO content measured in grams, multiplied by the food's GI, and divided by 100 [20]. GL can estimate the impact of CHO amounts, and GI on blood glucose concentrations at the same time, therefore; it can find a relatively new area in sports nutrition [19]. The LGL diets were found to induce smaller metabolic changes during the postprandial period and during exercise, which were characterized by lower carbohydrate oxidation and a concomitant, higher glycerol and FFA concentrations. Research on the effects of foods' GL on exercise performance and metabolism is still at an early stage of study and recent studies show that this concept may be worth to be considered in sports nutrition [21]. The purpose of the present study is to examine the effects of two iso-caloric mixed meals with

different GL on exercise performance and serum FFA concentrations of female athletes.

## 2. Materials and Methods

### 2.1. Study Design and Participants

This study is a double-blind randomized clinical trial with two periods and two treatments cross-over design. Sample size calculated based on the following formula suggested for cross-over trials:  $n = 2\sigma_d^2 [Z_{1-\frac{\alpha}{2}} + Z_{1-\beta}]^2 / \Delta^2$ , considering statistical power of %80, significant level of %5, and standard deviation of 2 for detecting mean difference as 1.4 for TTE as the pivotal variable [19]. It leads to 32 participants, and in order to compensating possible attrition, 38 subjects recruited. This study has done between Dec, 2012 and Mar, 2013, on 38 non-professional female athletes. Inclusion criteria were females with ages between 19 and 24 years, BMI between 19 and 24 kg/m<sup>2</sup>, and having a regular exercise program, three times a week for 90 minute. These athletes recruited from sport hall in Isfahan University of Medical Sciences. Exclusion criteria defined as having history of any chronic diseases, pregnancy or lactating status and taking any medications or supplements. The study was approved by the Ethical Committee of Isfahan University of Medical Sciences. All subjects were given written informed consent to take part in this study.

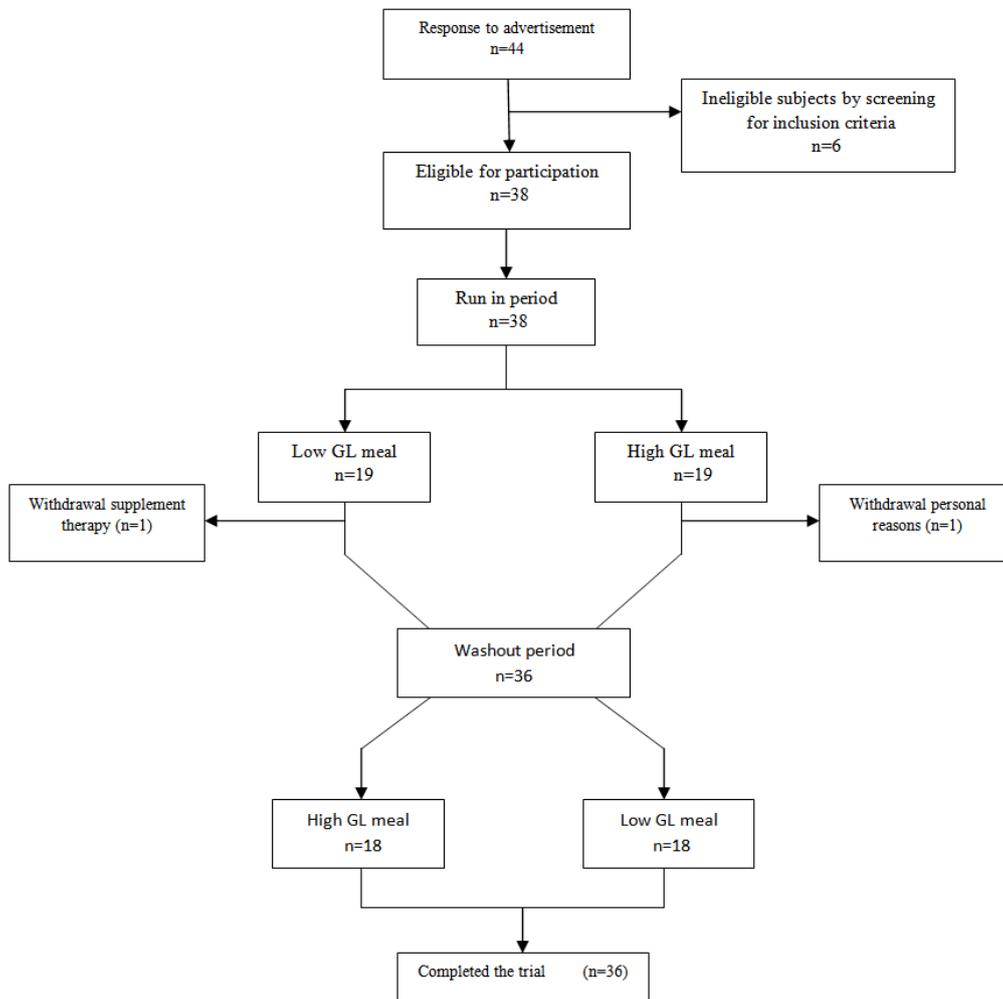


Figure 1. Subject's recruitment flow diagram

## 2.2. Procedures and Assessment of Study Variables

Subjects randomly assigned into high or low GL group [20]. Nineteen individuals participated in each group. They received high or low GL meals as their breakfast, and after 7 days as a wash out period, participants in each group received alternative meals. Subject's recruitment flow diagram is shown in Figure 1. From 38 subjects who enrolled in the study, 2 participants did not complete the study protocol. One person from the group with high GL meal dropped out the study due to personal reasons, and from low GL group, 1 female did not continue the procedure because of supplement therapy. Subjects recorded their routine diets and exercise plans 2 days before the first phase of trial, and it repeated before the second phase. Demographic and anthropometric characteristics and allergy to any components of tested meals obtained at baseline. HGL meal contained 75 g baguette white bread, 30 g cheese, 25 g boiled egg, and 20 g white sugar (GL=51.5) and LGL breakfast included 150 g baked lentils, 240 g orange, and 12 g oil (GL=10). Each breakfast provided approximately 403 kcal, 58% of energy from CHO, 15% and 27% of energy from protein and fat, respectively. GI and GL values calculated based on international table of GI and GL values [22], using the following formula:

GI (%) =  $\Sigma$  [ CHO content of each food item (g)  $\times$  GI ] / total amount of CHO in each meal (g); and

GL (g) =  $\Sigma$  ( CHO content of each food item (g)  $\times$  GI ) / 100 [24]. LGL meal in comparison with HGL meal contains 246 ml higher amount of water, so subjects consumed HGL meal with 246 ml more water. To alleviate participants' anxiety and their familiarization with test procedure, one week before starting the main trial, they requested to perform exercise test defined as 20 meters shuttle run pacer. [24]. At this point, time is recorded as TTE values. In an attempt to ensure that subjects run to exhaustion, rating of perceived exertion (RPE) was measured, using a Borg scale [25]. One week washout period was determined between phases of trial. All tests completed in the same laboratory and under the same environmental condition. Subjects instructed to refrain from caffeine or tobacco consumption for 24 hours before trial. 10 mL venous blood samples were obtained at two time points: premeal (after a 12-hr overnight fast) and immediately after exercise. Serum FFA were determined by enzyme linked immunosorbent assay (ELISA) using EAST BIOPHARM kit (HANGZHOU EAST BIOPHARM CO., LTD, China). Subjects should consume tested meals, 3 hours before running to exhaustion in a shuttle run pacer and we ask them to avoid from any strenuous physical activity for 3 hours and then after a 5-minute warm-up, subjects run to exhaustion in a 20-meter shuttle run pacer.

## 2.3. Anthropometric Measurements

Anthropometric measurements assessed at baseline (Table 1). Body weight was measured without shoes and in minimal clothing state by a digital scale to the nearest 0.1 kg (Seca, Hamburg, Germany). Height was measured with no shoes by using a non-stretched tape to the nearest 0.1 cm. Body mass index (BMI) calculated as weight in

kg divided height in squared centimeters. Fat free mass was assessed by hand-to-foot bioelectrical impedance analysis method using a body composition analyzer (PLUSAVIS 333, Korea).

**Table 1. Anthropometric and demographic characteristics of subjects**

variables	Mean $\pm$ SD
Age (yrs)	19.4 $\pm$ 0.84
Height (cm)	164.3 $\pm$ 5.3
weight	60.1 $\pm$ 6.0
BMI (kg/m <sup>2</sup> )	22.1 $\pm$ 1.5
W.H.R	0.76 $\pm$ 0.03
FFM (%)	73.51 $\pm$ 2.99

BMI: Body Mass Index; FFM: Fat Free Mass

W.H.R: waist to hip ratio.

## 2.4. Statistical ANALYSIS

Quantitative variables were represented as mean  $\pm$  SD. To assess the normal distribution of studied variables one sample Kolmogorov-Smirnov test and P-P plot was used to evaluate the effect of considered treatments, ANOVA test for a 2 $\times$ 2 cross-over design conducted (using R free statistical software version 2.6.1). The effect of treatment, time, time  $\times$  treatment as well as carry-over effect were tested using relevant F test. Within group comparisons over the study period for RPE were conducted using Friedman and Wilcoxon Signed Ranks Test. P<0.05 was considered as statistically significant level.

## 3. Results

Anthropometric and demographic characteristics of participants are shown in Table 1. Subject's recruitment flow diagram is shown in Figure 1. The effect of HGL or LGL meals on TTE is shown in Figure 2. No significant difference in TTE was found between two treatments.

**Table 2. Effect of high and low GL meals on rating of perceived exertion at first to fifth minutes of exercise**

Time of exercise (min)	High GL meal	Low GL meal	Z ( P Value) *
1	2.33 $\pm$ 1.19 (n=36)	1.83 $\pm$ 1 (n=36)	-2.63 (0.009) †
2	4.56 $\pm$ 1.48 (n=36)	4.11 $\pm$ 1.36 (n=36)	-2.27 (0.02) ‡
3	7.34 $\pm$ 1.57 (n=35)	6.91 $\pm$ 1.79 (n=34)	-1.45 (0.14)
4	8.57 $\pm$ 1.46 (n=21)	8.11 $\pm$ 1.59 (n=19)	-0.9 (0.36)
5	8.57 $\pm$ 0.97 (n=7)	8.6 $\pm$ 1.07 (n=10)	-1 (0.31)
P Value #	<0.001	<0.001	

\* using Wilcoxon signed ranks test

† significant difference for low GL meal (p<0.01)

‡ significant difference for low GL meal (p<0.05)

# significant effect of time by trial in each group, using Friedman test.

RPE increased with exercise time in both high and low GL meals (p<0.001). The effects of HGL or LGL meal on RPE at first to fifth minutes of exercise are shown in Table 2. Although consumption of high GL meal at the first and second minutes of exercise led to higher RPE

values than low GL meal, but comparison of the overall effect between two meals reflected no statistically significant difference. There were no differences in serum

FFA levels at baseline between two groups. Mean changes of serum FFA were higher in LGL than HGL meal (118.79 vs 23.83 p=0.08; Figure 3).

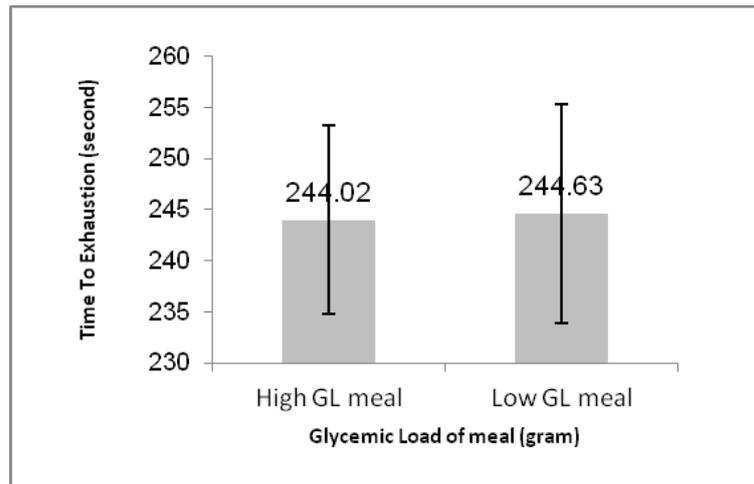


Figure 2. Effect of meals with high and low glycemic load on TTE.

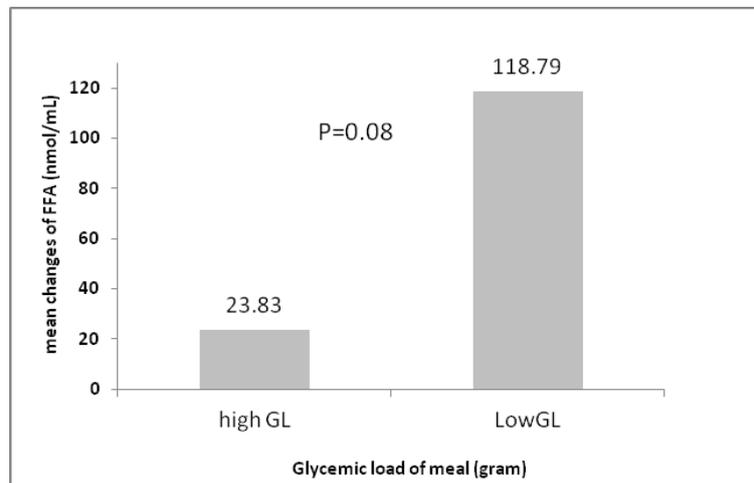


Figure 3. Effect of LGL or HGL meal on mean changes serum FFA concentrations

## 4. Discussion

We assessed the effects of LGL and HGL meals on TTE and serum FFA values 3-hr before shuttle run pacer in non-professional female athletic students. There was no significant difference in TTE between two meals however mean changes of serum FFA were higher in LGL than HGL meal. As we know, it is the first study which assessed the role of pre-exercise GL meal on endurance exercise performance in Iranian athletics. In a similar study, Chen et al. used three iso-caloric meals (~ 630 kcal) with various GI and GL values namely high GI and high GL (65% CHO, GI= 79, GL= 82), low GI and low GL (65% CHO, GI=40, GL= 42), high GI and low GL (65% CHO, GI=78, GL= 44) at two hours before exercises. Eight male runners completed one-hr run at 70% VO<sub>2</sub> max that followed by a 10- km performance run. There was no significant difference in time to complete the preloaded 10-km run, between three meals but serum FFA concentrations were higher in LGL than HGL meal [19]. Several studies attempted to assess the effects of meals with various GI levels that are consumed in different time

prior to exercise plan on improving athletes' performance [12,15,26]. Wu et al. investigated the effects of ingesting LGI (GI= 37) and HGI (GI= 77) meals at three hours prior to running of male recreational runners. The assessment of their exercise performance showed that run time for runners with LGI meal was significantly greater than the mentioned time for individuals with HGI meals [12]. The same founding was seen in Moore's study. They observed that runners who consumed low versus HGI foods (30 vs 72), at 45 minutes prior to the exercise reflected a significant improvement in their 40-km performance [15]. Some of studies show no improvement in exercise performance after receiving LGI meals comparing with HGI meals [16-18]. Febbario et al. studied receiving low or HGI meals on trained men (52 or 85) or even placebo (diet jelly) at 30 minutes before a cycling period, at 70% VO<sub>2</sub>max. No significant difference observed in their work output performance among three meals but serum FFA were higher in LGI compare with HGI meal [17]. Despite, the controversial observations in individuals' exercise performance after low vs high GI meals, there was a relative shift in substrate utilization from carbohydrate to fat utilization, following low GI meals [16,21]. In our study RPE increased during the exercise period in both

LGL and HGL meals, but there was no significant difference between two groups. Similar results obtained from several studies which evaluated the effects of consuming foods with different GI before exercise on RPE values [9,19,27]. Stevenson et al. examined the effects of three hr pre-exercise mixed breakfast intake with HGI or LGI content (78 or 44) on substrate utilization of healthy active women, during a 60 minutes run at 65% VO<sub>2</sub>max. No significant difference observed between high or low GI meals in rating of perceived exertion [9]. While, in another study by Little et al. indicated an isoenergetic LGI (GI= 32) meal lowered RPE amounts in three 90-min intensive running trials compared with fasted control group. However, it is difficult to compare the results of different studies because of difference in the content of consumed meals, feeding time prior to exercise plan or performance assessment methods. In most of previous studies, only one food used as a LGI or HGI [17,28,29] but in the present study, breakfast composed of a variety of foods with high or LGL contents, matched for energy content and macronutrients composition. These food were chosen from food items which are used in Iranian dietary habits. It should be mentioned that Donaldson et al. expressed feeding time at one hour or less before exercise, accompanied with higher blood glucose and free fatty acids concentrations at the end of exercise; however, feeding at one to three hours prior to exercise results in higher blood glucose or free fatty acids during athletes' exercise [30]. Based on this finding, we selected three hours as suitable feeding time, before exercise. Assessment exercise performance in a limited time period in contrast with following a time to exhaustion protocol showed that the latter approach may not be a sufficiently sensitive method. This declare is based on endurance competitions which often require completing a set of work in the fastest possible time [11]. Using crossover design helps us to control the effects of confounding covariates. Furthermore, the feeding trial design of this study was useful in cooperation of participants. There are several limitations in the present study, first selection of two mixed foods as a tested meals with different GL values in accordance with habitual Iranian diet can limit our findings. If there were no restrictions, we'll be able to choose foods with lower or higher GL in low or high GL groups respectively; So that there were more differences in GL levels between two groups. Second, it should note that subjects in this study were not professional athletes, while exercise plan and individuals' fitness can effect on the mentioned markers. Moreover, in the present study subjects completed a short time running period, and time periods and intensity of exercises can reflect different conclusion. It is suggested that further research with higher intensity and longer duration exercises in various types of athletes be evaluated in the future.

## 5. Conclusions

In conclusion, female athletic students who ingested of LGL meal 3 hr before exercise, experienced a longer run time to exhaustion values compare with those with HGL meal; however the difference was not significant. Mean changes of serum FFA were higher in LGL than HGL meal. There was no difference in RPE between two meals.

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