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Moderate exercise increases gastric accommodation in healthy men and women

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ABSTRACT

Physical exercise can bring benefits to the cardiovascular and gastrointestinal tract. However, little is known about the adequate exercise intensity and how exercise responses are affects by sexual differences**.**

Aims: To evaluate the effect of an acute treadmill exercise session at ~ 75% of HRmáx on hemodynamic parameters and the gastric compliance of men and women.

Methods: The study included 22 men and women aged 18 to 29 years, physically active. The exercise consisted of a treadmill session at 75% of HRmáx. We monitored blood pressure (BP) and heart rate (HR). During the drink test, volunteers were asked to ingest 15mL of chocolate in 1min intervals, marking their satiety on a graphical scale combining verbal descriptors.

Results: There was a significant increase of hemodynamic parameters for both sexes after the exercise session ($p < 0.05$). Exercise was also able to increase total ingested volume, time of ingestion and calories ingested ($p<0.05$). Concerning the drink test, no influence of the exercise session on satiety scores was observed in the groups studied ($p>0.05$).

Conclusions: Acute moderate exercise promoted significant increase in hemodynamic parameters and gastric compliance in subjects of both sexes. However, there was no effect on the satiety scores and the volume ingested at each score.

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KEYWORDS

Physical exercise; Hemodynamics; Gastric accommodation.

INTRODUCTION

Physical exercise is defined as any movement produced by the locomotor system that involves contraction and muscle relaxation and energy consumption[1]. In addition to the muscles, several organs and systems have the capacity to adapt to the practice of exercise, such as the gastrointestinal tract and the cardiovascular system[1-3].

Regarding cardiovascular system, acute responses are characterized by the increase of mean blood pressure and heart rate[1,3]. In the gastrointestinal tract, gastric emptying and intestinal absorption seems to be affected by exercise, and are important steps to optimize the sports practice, since the stomach and intestine are the regions where the digestion and absorption of carbohydrates and fluids will take place, which will be conducted to the active muscle[2].

In this sense, it is common to have symptoms such as accumulation of fluid in the stomach, feeling of nausea, diarrhea and vomiting in athletes in high intensity exercises. These effects are usually mediated by the secretion of hormones in gastrointestinal tract such as cholecystokinin (CCK), gastrin, glucagon like peptide 1 (GLP-1), motilin and, particularly, the release of neurotransmitters as catecholamines, endorphins and prostaglandins by the working muscles. Studies have demonstrated an altered secretion in these mediators in response to exercise that can modulate the individual's appetite and satiety[2,4].

However, little is known on how the association between hemodynamic and gastrointestinal responses to exercise may influence gastric accommodation. In addition, few studies attempt to investigate the differences between sexes, leaving a gap on how exercise can influence gastrointestinal repercussions in women. Therefore, this study aims to evaluate the effect of acute exercise of moderate intensity on hemodynamic parameters and gastric accommodation in healthy men and women.

MATERIALS AND METHODS

Sample

In the study, were included male (n=11) or female (n=11), young people between 18 and 30 years of age, who were willing to participate in the study and who practiced regular physical activity. Those with clinical conditions that modified gastrointestinal tract (e.g gastroesophageal reflux disease, gastritis, inflammatory bowel diseases, etc.), or who had some chronic illness, such as obesity, diabetes mellitus, inflammatory bowel disease, respiratory problems and hypertension were excluded from study. All participants signing of an informed consent, as recommended in the Resolution No. 466/12. The project was approved by the Research Ethics Committee of the Federal University of Piauí, under the number 57112016.4.0000.5214.

Instruments / Procedures

The anthropometric evaluation was performed by measurement of body weight and height. From these data, the body mass index (BMI) was calculated. In addition, the body composition was analyzed using the electric bioimpedance method, by means of the InBody® 120 model. Prior to the test, previous recommendations were made to prepare for the procedure.

Evaluation of Hemodynamic Parameters

Blood pressure monitoring was performed with the aneroid sphygmomanometer and stethoscope, after the participant stayed 10 minutes at rest. Systolic arterial pressure (SAP) values lower than 130 mmHg and diastolic arterial pressure (DAP) less than 85 mmHg were considered as the reference standard[5]. The mean arterial pressure (MAP) at rest and exercise was calculated by means of the following formulas: Resting MAP = 2/3 SAP + 1/3 SBP; MAP exercise = ½ DBP + ½ SBP. The heart rate at rest, during and after exercise was monitored by means of the Polar® RS800x heart monitor measured in beats. In addition, the maximum heart rate was calculated according Miller et al[6].

Exercise Protocol

Regarding the exercise protocol, the volunteers were submitted to an acute exercise session, after the anthropometric parameters body composition and BP and HR were measured at rest and after exercise. The exercise was conducted on a treadmill in the Laboratory of Exercise Gastrointestinal Tract in Federal University of Piaui. initially the participants performed a 5 min warm-up in treadmill with overload of the 50% of the HRmax. The exercise protocol consisted the 25-min of in walking with overload of the 75% of maximum heart rate. At the end, participants performed 5-min at recovery.

Gastric Accommodation Assessment (Drink Test)

The evaluation of gastric accommodation was performed according to a protocol described by Meyer-Gerspach et al.[7]. Initially the volunteers were instructed to perform a nighttime fast of 10 hours. The following day they were given 2 hours before the test a standardized meal which contained the following composition: 200ml of grape juice (119Kcal, carbohydrate 29g, protein 0g, total fat 0g) and a pack of 25g salted Club wafer Social® original taste (120Kcal, carbohydrate 17g, protein 2.1g, total fat 4.8g). Drink Test consisted in offering the volunteers 15 ml / min of a liquid chocolate drink Nescau® (9.77 Kcal, 1.5 g carbohydrates, 0.375 g proteins and 0.2625 g total fats) where they were instructed to mark their satiety through a scale (0 = I feel nothing, 1 = starting to fill, 2 = a little full, 3 = I'm full, 4 = too full, 5 = I cannot take it anymore). Participants were instructed to leave meal intake when a score of 5 was achieved. At the end of the test the total intake (mL), calories ingested (kcal) and total time (min) taken to fill were quantified. All procedures were performed at the first visit and at the second visit after the acute exercise protocol.

Statistical analysis

The Prisma 6.0 software was used for the statistical analysis. Data were expressed as mean ± standard deviation (SD), assuming significant values $p < 0.05$. Data normality was tested using the Shapiro-Wilk test. Then, Student's t-test paired was used for variables with normal distribution for purposes of comparison between the groups studied. For the data with non-normal distribution the Wilcoxon test was used. To analyze the results of the drink test, two-way ANOVA was used, with Tukey's test used to compare the means between the different treatments. The correlation analysis was conducted by nonlinear regression model of the plotted curves, starting from the simple values of each group.

RESULTS

The mean values and mean standard error of age, anthropometric parameters, body composition and VO_2 max used to evaluate the characteristics of the participants of this study are presented in table 1.

In table 2 shows results obtained for the hemodynamic parameters SAP, DAP, MAP and HR in men and women, in rest or moderate exercise. We observed a significantly increases in all hemodynamic parameters ($p<0.05$) SAP, DAP, MAP and HR after exercise compared with rest situation in both sexes.

In table 3, are presented the values of the total intake, total time and ingested calories in men and women in rest or submitted to moderate exercise. We observed a significantly increases ($p<0.05$) in the all parameters and all groups after moderate exercise compared with rest situation.

About the scores of satieties obtained by drink test, we not observed differences in the isolated scores in both men and women for all parameters in rest situation or moderate exercise ($p<0.05$). In respect to the correlation analysis between total intake and MAP or HR we observed a positive correlation between total intake and HR in men only ($r=0,3280$; $p<0.05$). We not observed differences in all parameters of the woman group.

Table 1. Mean values and standard deviation of age, anthropometric parameters, body composition and VO_2 max for men and wo-

Parameters	Men		Women	
	Mean	± SD	Mean	± SD
Age (years)	23,2	0,6	23,0	0,6
Body Weight (kg)	74,9	3,0	55,8	1,7
Height (cm)	173,3	1,6	159,3	1,0
BMI (kg/m²)	25,0	1,2	22,0	0,7
Body Fat (%BF)	20,2	2,1	29,3	1,4
Body Water (L)	43,1	1,2	28,6	0,5
Protein (kg)	11,7	0,3	7,7	0,1
Minerals (kg)	3,9	0,1	2,8	0,5
Muscle Mass. (kg)	32,0	2,0	21,2	0,4
Body Fat (kg)	20,4	4,5	16,6	1,1

BMI = Body Mass Index. Reference values: BMI = 18,5 – 24,9 kg/m²; Body fat = 10-20% (men) and 18-28% women.

Table 2. Response of hemodynamic parameters in men or women in rest or submitted to moderate intensity exercise.

	Men		Women	
	Rest	Exercise	Rest	Exercise
SAP (mmHg)	125.0 ± 5.2	164.2 ± 13.7*	111.7 ± 5.7	138.3 ± 11.9*
DAP (mmHg)	91.6 ± 7.1	126.7 ± 17.2*	66.6 ± 13.0	70.8 ± 12.4*
MAP (mmHg)	102.7 ± 6.1	145.4 ± 13.8*	81.5 ± 9.2	104.6 ± 8.1*
HR (bpm)	68.0 ± 7.1	138.7 ± 14.6*	75.3 ± 6.0	140.2 ± 5.8*

Data are expressed as mean ± SD. The results were analyzed by paired Student's T-test. * p <0.05 vs. rest situation. SAP: systolic arterial pressure; DAP: diastolic arterial pressure; MAP: mean arterial pressure; HR: heart rate.

Table 3. Response of total intake, total time of ingestion and calories ingested in men or women in rest or submitted to moderate intensity exercise.

	Men		Women	
	Rest	Exercise	Rest	Exercise
Total Intake (mL)	1350 ± 139.8	1669 ± 182.3*	1088 ± 106.0	1369 ± 112.0*
Total time (min)	91.2 ± 9.2	120.4 ± 15.5*	70.5 ± 7.4	92.6 ± 7.4*
Calories Ingested (kcal)	877.5 ± 90.8	1085 ± 118.5*	706.9 ± 98.8	889.7 ± 72.7*

Data are expressed as mean ± SD. The results were analyzed by paired Student's T-test. * p <0.05 vs. rest.49

DISCUSSION

In the present study, we evaluated the effect of an acute session of moderate treadmill exercise on hemodynamic responses and gastric accommodation in healthy volunteers of both sexes.

About the hemodynamic responses, the moderate exercise, it was observed that exercise was able to raise SAP, DAP and MAP associated with a post-exercise tachycardia. These results corroborate the literature, where they show that acute exercise promotes an increase in heart rate and blood pressure, usually followed by a hypotensive response in both men and women[8]. In this sense, we could prove that our study protocol was effective in promoting organic and functional changes in the volunteers. Among the mechanisms that may explain the increase in hemodynamic variables observed in this study are the activation of the sympathetic nervous system, which elevates BP and increases the secretion of vasodilators by skeletal muscle, including nitric oxide and carbon dioxide, the latter responds to increased HR and ejection volume[9].

The activation of the sympathetic nervous system is one of the main factors responsible for the increase in BP after an exercise session, since it is predominant to the detriment of the parasympathetic "via vagal tonus", causing an increase in HR and cardiac output and flow deviation in skeletal muscle[10].

In this discussion, it is also relevant to observe the similarities found for the BP behavior in the men and women evaluated in this study, except for DAP, which increased in men, but remained stable in the women. It was also observed that in the current study, men's DAP increased to higher values (110 mmHg after the exercise session), while in women, these values remained similar to those before the exercise session, as previous described in the literature. The increase in all hemodynamic parameters evaluated was superior in men compared to women, which agrees with studies on the subject and can be explained by the higher body weight and muscle mass of the men participating in the study[10].

Regarding the effects of acute moderate exercise on gastric accommodation, it was found that an exercise session was able to increase the total volume ingested, the time of the meal and the number of calories ingested. It is important to mention that acute treadmill exercise increased gastric accommodation in both sexes in the present study. However, it is noteworthy that men exhibited higher volume intake, higher caloric intake and longer time of ingestion compared to women, which can be explained by the greater muscle mass of males, since muscle mass is the main factor which determines energy expenditure during physical exercise, which seems to be related to caloric intake and to regulate appetite[11].

In addition, a possible explanation for the effects of exercise on gastric accommodation concerns the activation of the vagal cholinergic pathway, which in turn increases gastric tone and release of nitric oxide, promoting the increase of gastric compliance[12].

However, in this study there was no significant difference in satiety scores when compared to rest and after moderate exercise session in healthy men and women, despite the increase in gastric accommodation in these individuals. Therefore, a moderate exercise session appears not to be enough to alter satiety in healthy men and women.

A factor that may contribute to explain the results of this study is the relation between physical exercise and the secretion of appetite hormones, such as ghrelin and GLP-1 which has not yet been fully elucidated in the literature[13]. However, in a meta-analysis conducted by Mattin et al.[13], it was found that acute exercise seems to cause suppression of acylated ghrelin secretion, and increase secretion of GLP-1, which appear to increase satiety. It should be emphasized that the stimulation of these hormones can be influenced by factors such as gender, type and intensity of exercise and, in particular, the timing of the test, since the rise of anorexigenics and suppression of orexigenic hormones secretion are more commonly observed between 1 and 2 hours after the training.

In the study we associated the alterations in gastric accommodation to sympathetic stimulation via the increase in blood pressure and heart rate. Moreover, we observed positive correlation between HR and volume ingested for males only. These data reinforce that stimulation of the sympathetic nervous system leads to increased HR and the variation of the latter leads to changes in the sympathetic / parasympathetic balance. The vagus nerve, in turn, regulates the adaptive relaxation of the proximal stomach and the fundal-antral coordination acting on gastric compliance[14].

CONCLUSIONS

Moderate-intensity exercise stimulate cardiovascular system inducing increases in blood pressure and heart rate. Moreover, exercise modifying the gastric accommodation increases the total intake and the calories ingested in both men and women. This study is the first one that takes into consideration the sexes, proposing an explanation for the gastrointestinal alterations caused by the exercise. We suggest new studies for identification of the possible hormonal mechanics involved in this phenomenon.

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