Effect of Continuous and Interval Physical Exercise on Weight and Biochemical Profile of Pregnant Wistar Rats and Consequences on Fetal Body Weight

EXERCISE AND SPORTS MEDICINE CLINIC

Original Article

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ABSTRACT

Exercise training is known for its benefits to the body and mind. However, little is known about the effects of endurance training intensity on pregnancy. We tested the effects of continuous and intermittent exercises (maternal swimming) on the biochemical profile of pregnant Wistar rats and the effects of these exercises on the fetal body weight. The pregnant females (n=60) were divided in control group (CG), continuous exercise group (CONG) and intermittent exercise group (ING). GC group rats did not practice exercises. CONG group rats practiced continuous swimming for 45 minutes a day (five days a week) carrying a bag with 5% of its body weight. ING group rats practiced intermittent swimming (15 seconds of swimming and 15 seconds stopped) for 45 minutes a day (five days a week) carrying a bag with 15% of its body weight. These exercises were made from the day one until 20^0 day of pregnancy. At the end of this period, we analyzed the mother's glycemia, cholesterol, HDL-C, LDL-C and triglycerides. We also analyzed fetal body weight. No significant modifications on glycemia and plasma lipids (except for LDL-C) were observed in the tree groups. We observed reduction on the fetal body weight in the pups that had their mothers practicing exercises: fetal body weight in CG>ING>CONG (4.153 ± 0.649; 3.682 ± 0.070 and 3.453 ± 0.052 respectively). These results showed that the continuous and intermittent exercise only performed in pregnancy period decreases fetus body weight.

Keywords: exercises, pregnancy, blood glucose, lipids, birth weight.

INTRODUCTION

Regular physical activity practice is acknowledged as an important factor for health preservation, recovery and maintenance and this regularity leads to physiological, morphological and biochemical adaptations important to the homeostasis maintenance. However, the effects of physical exercise during pregnancy and on health of the offspring are not completely known. Research in this field requires models which use animals so that the metabolic and muscle alterations in the body can be known[1-3].

In women, physical activity practice may bring, besides metabolic benefits and body weight reduction, mental wellness. During pregnancy physiological and psychological alterations which require special care are observed and this also applied to physical exercises[4]. There are studies which show that in this phase women can perform low and moderate intensity exercises with no risk to the herself or the baby[5]. Other studies show that pregnant women practitioners of moderate physical activity present better evolution in pregnancy and delivery, when compared with sedentary women. On the other hand, practice of more intense exercises for long periods during pregnancy lead to potential risks to the fetus, creating factors which can cause fetal stress, intrauterine growth restriction and premature births. Birth weight influences on the health status and survival chances[6,7]. Birth weight is the singular fact which influences the most on the health status and child survival chances. The risks to get sick or die during infancy are very remarkable for children born with low weight[8].

Another factor which should be considered is the difference between effort in performance of ground and aquatic exercises. There are studies which show that there is heart rate reduction during immersion, which may reflect on the energetic cost[9,10].

Activity practice and its contribution to pregnancy are acknowledged; however, the studies are not very clear about the intensity and frequency which allow inferring on the deleterious or beneficial effects of exercise practice during pregnancy. There is not standardization about the activity which should be recommended. In animals models, moderate physical activity practice during pregnancy may have positive effects on the lipid profile of the female rats[11].

Thus, the aim of the present study was to evaluate the effects of continuous and interval physical exercises on the biochemical profile of pregnant Wistar rats and the consequences in fetal body weight. These results may contribute to future standardization of exercises aimed at women in gestational phase.

METHODS

Animals

The experiment was approved by the Ethics in Research Committee of UNIMAR (CEMA). The animals were kept in an animal facility with a 12-hour light/dark cycle with room temperature of 22 ± 2ºC, cycle and relative humidity of 60 ± 5%, water and food *ad libitum* and were treated according to the *Guide to the Care and Use of Experimental Animals*, which tells about the principles of the Canadian Council on Animal Care.

Virgin Wistar female rats weighing approximately 180g and Wistar male rats weighing about 250g, provided from the Experiment Center in Animal Models (CEMA), UNIMAR – Marília, SP were used.

Experimental sequence

All animals were adapted to the water environment (first adaptation) for two weeks before the beginning of the experiment.

Adaptation started with initial water level of five centimeters in the swimming pool for five minutes. Water level was gradually and daily increased until reaching 10 centimeters.

Subsequently, the animals were randomly divided in three experimental groups.The groups which would perform exercise went through an exercise adaptation (second adaptation).

Water and food consumption was daily evaluated. The rats were weighted on the first, seventh, 14th and 20th pregnancy days.

Mating and pregnancy period

For mating, the female rats were sorted in four per polyethylene cage, in the presence of a male ratat the end of the afterno on. On the following morning, the vaginal smear was performed. The factors indicative of pregnancy were: presence of sperm and diagnosis of the estral phase of the estrous cycle (this was considered day zero of pregnancy).

Once pregnancy was identified, the female rats were kept in individual cages duirng 21 days.

Physical exercise training protocol

Three experimental groups of pregnant rats were sorted and each group had 15 animals: CG control (sedentary rats); a group which was submitted to continuous exercise (CONG); and a group which was submitted to interval exercise (GIN). The second adaptation was performed (for CONG and ING), exercise time ranged from 15 to 45 minutes and load was of 5% of body weight in the continuous exercise and 15% in the interval exercise.

Day 1: 15 minutes with no load
Day 2: 30 minutes with no load
Day 3: 15 minutes with load and 30 minutes without it
Day 4: 45 minutes with load
Day 5: 45 minutes with load

After exercise adaptation, the rats from CONG performed the exercise program which consisted of swimming for 45 daily continuous minutes in an individual, 20-cm long, 15-cm wide and 32-cm deep glass swimming pool, with water between 28ºC and 31ºC. Overload was 5% of body weight (weekly corrected according to the animal's weight) with the use of mini sandbags attached to their thorax. This procedure was performed five days per week until the 21st day of pregnancy.

The intermittent exercise program consisted of swimming with total duration of 45 minutes in swimming at the conditions previously described with 15-second exercise stimuli by 15 seconds of rest, five days per week until the 21st day of pregnancy. Overload was 15% of body weight weekly corrected (also with mini sandbags attached to their thorax).

Animalslaparotomy

On the 21st day of pregnancy, the rats were anesthetized and killed with sodium pentobarbital (Hypnol) for subsequent bleeding (for blood collection) and laparotomy performance. The newborn and their respective placentas were weighed on a high precision scale. The placental index was calculated by the reaction between placental weight and fetal weight according to the methodology by Calderon *et al.*[12].

Biochemical parameters evaluation of the female rats

The blood samples of the animals had their glycemia, total cholesterol (TG), LDL-C, HDL-Cand triglycerides (TGC) (LABTEST for glycemia, total cholesterol, HDL-Cand triglycerides and WIENER LAB for LDL-C)analyzed with the aid of commercial kits.

STATISTICAL METHODOLOGY

Data of the studied variables were analyzed by analysis of variance and complemented with the Tukeytest with significance level of 5%.

RESULTS

Table 1 shows that statistically significant variations have not been observed for body weight of the female rats. Concerning the biochemical profile of the different experimental groups, it was observed that only the LDL-c values suffered significant alterations in the groups which exercised. Table 2 shows that there was not statistically significant difference for placental weight in the different experimental groups, but weight of the pups of Wista rrats submitted to exercise during pregnancy statistically ranged between groups. Additionally, it can be observed that the group which practiced continuous exercise was the one which obtained the lowest weight in the pups when compared with the control group and with the group which practiced intermittent exercise.

Table 1. Mean, standard deviation and result of the weight and biochemical profile statistical test of the Wistar female rats submitted to continuous physical exercise.

Variables	CG	ING	CONG	p-value
Weight	227.07 ± 73.14	208.86 ± 73.22	219.85 ± 70.94	0.1571
Glucose	107.33 ± 21.65	95.20 ± 23.95	90.00 ± 9.49	0.5985
CT	62.44 ± 16.51	63.64 ± 29.09	73.00 ± 29.19	0.6847
TGC	246.33 ± 139.62	183.82 ± 68.23	135.63 ± 78.06	0.0864
HDL-C	34.4 ± 3.3	35.40 ± 26.86	34.73 ± 21.80	0.5420
LDL-C	67.86 ± 5.58	50.09 ± 9.89	53.75 ± 10.74	0.0024

CG: control group; ING: interval exercise group; CONG: continuous exercise group.

Table 2. Mean,standard deviation and result of the placental and fetal weight statistical test according to the exercise group performed by the mothers.

Variables	CG	ING	CONG	p-value
Placental weight	0.431 ± 0.069	0.418 ± 0.072	0.429 ± 0.077	0.2483
Offspring weight	4.153 ± 0.649	3.682 ± 0.070	3.453 ± 0.052	0.0000

CG: control group; ING: interval exercise group; CONG: continuous exercise group.

DISCUSSION

The use of water for physical activity performance presents many advantages for the practitioner, since it reduces the impact on the joints and decreases the risks of injury, even to special groups such as the one with pregnant individuals[13,14].

Significant alterations have not been observed in the food consumption or weight of the female rats which practiced interval and continuous exercise compared to the control group. These data are corroborated by the results by Volpato *et al.*[11]. However, a consensus has not been reached in the literature about the correlation between gestational weight gain and physical exercises practice[14,15], but some studies have mentioned reduction in weight

gain[16,17]. Lana *et al.*[18]studied the effects of forced exercise in rats and observed that there was not statistically significant difference between the animals trained in low intensity and the untrained ones; however, lower final body weight was detected in the animals from the group with high intensity compared with the ones from the untrained group.

Concerning the biochemical profile, this study did not show significant alterations between sedentary mothers and the ones which practiced interval and continuous exercises. The fact that the rats have practiced physical activity only during pregnancy may have been insufficient to promote significant alterations in the lipid profile. There are studies which show that one of the biggest benefits from regular physical activity is improvement in the lipid profile, but this is only observed in the long term[19]. Besides reducing dyslipidemia episodes, constant and regular physical activity practice is also beneficial to the control of glucose intolerance, diabetes *mellitus*, chronic complications derived from the metabolic syndrome, such as cardiovascular disease, both in animal and human models[20,21].

The results of this investigation point to fetal weight reduction at birth when the mothers practiced physical exercise; however, alterations in placental weight have not been observed. Placental and newborn weight can be influenced by maternal factors, such as nutrition, diabetes, hypertension and other pathologies and syndromes onset. In addition to these factors, excessive physical exertion can also be an influence and therefore, the way and intensity it is administered should be considered[22-25].

Volpato *et al.*[11]have also observed fetal weigh treduction after a swimming program. Other authors also found similar effects in animals and humans. Further studies with moderate and high intensity exercise models do not show differences between groups concerning birth weight. On the other hand, different reports show that moderate intensity exercises during pregnancy may increase birth weight, while more intense exercises with high frequency, kept for long periods during this phase, may result in children with low weight[26-31].

CONCLUSION

It can be concluded that continuous and intermittent exercise practice, in the experimental model used, did not produce substantial alterations in the weight and metabolic profile of rats in gestational period or interfered in the placental weight, but caused reduction in fetal weight.

All authors have declared there is not any potential conflict of interests concerning this article.

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