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COMPARISON OF THE RATING OF PERCEIVED EXERTION AND OXYGEN UPTAKE DURING EXERCISE BETWEEN PREGNANT AND NON-PREGNANT WOMEN AND BETWEEN WATER AND LAND-BASED EXERCISES

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ABSTRACT

The purpose of the present study was to assess the differences in ratings of perceived exertion (RPE) and oxygen uptake (VO_2) behavior during water and land-based exercise, performed in the exercise intensity of the first ventilatory threshold between pregnant and non-pregnant women. Seven pregnant (gestational ages between the 27th and 30th week) and seven non-pregnant women performed two continuous cycle ergometer tests (water and land-based) at the first ventilatory threshold intensity. During all sessions, respiratory gases were collected with a portable AEROSPORT KB1-C mixing box gas analyzer. A pneumotach was used with a neoprene mask. Heart rate (HR) measurements were obtained with a POLAR F1. Data were collected every 20s. RPE on Borg scale from 6 to 20 was derived at the end of the exercise. One-way ANOVA was applied for repeated measures using the post-hoc Bonferroni test ($p<0.05$). No significant differences were found in VO_2 or RPE when comparing water with land-based exercise. In the same way, no significant difference was found between pregnant and non-pregnant subjects. We suggest that RPE can be used for water and land-based exercise prescription on cycle ergometer at the intensity of first ventilatory threshold, for both pregnant and non-pregnant women.

Keywords: RPE on Borg scale, pregnancy, cycle ergometer.

INTRODUCTION

The concept of perceived exertion was introduced in the end of the 1950 decade with methods to measure general perceived exertion, local fatigue and breathlessness[1]. The ratings of perceived exertion (RPE) can be defined as relative tension which occurs in the muscular, nervous, cardiovascular and pulmonary systems during physical activity[2,3]. The RPE Borg's scale[1]is the most widely used for the perceived exertion tests, since in the scale the classifications lineally increase with the exercise intensity, heart rate (HR), and oxygen consumption ($\dot{V}O_2$).

Many authors recommend that pregnant women remain exercising at the same effort intensity from before pregnancy[4-6]. However, this statement is questioned by some authors who state that during pregnancy many physiological variables are altered and this fact may alter their perceived exertion to exercise[7-9]. In the literature, there are studies which measure the role of the RPE in the prescription of different exercise modalities[10-14]and have been also used in investigations which need to prescribe the exercise intensity in different environment[15-17]. When analyzing the investigations found on RPE in different exercise modalities on land, we observed that there are clashing opinions about the RPE use for pregnant women[18]. Regarding the $\dot{V}O_2$, there are methodological differences in the studies which approach this issue, not making it clear whether the environment and pregnancy may result in distinct $\dot{V}O_2$, when compared with the non-pregnant state.

Thus, this investigation has the aim to assess whether there are differences in the RPE behavior and in the $\dot{V}O_2$ in water and land-based physical activity performed in the heart rate of the first ventilatory threshold between pregnant and non-pregnant women.

METHODS

The sample of this study was composed of seven pregnant women, with gestational age between 27th and 30th weeks, and seven non-pregnant women with mean age of 31.29 ± 2.21 and 32 ± 3.27 years, respectively. The calculation of the sample "n" was performed in the PEPI program, version 4.0 with power of 80%. The pregnant group was selected first, and according to the similar characteristics of age and body mass index (BMI), the individuals of the non-pregnant group were chosen. The pregnant women were members of a group of water gymnastics for pregnant women of a gym of Porto Alegre, and the non-pregnant women were volunteers from the academic environment and Porto Alegre community. The participation was voluntary.

There was no significant difference in the sample characteristics between the groups under investigation (Table 1). Inclusion criteria for the pregnant group were the gestational age (between the 27^{th} and 30^{th} weeks) and medical authorization for exercise practice. The non-pregnant group should have BMI similar to the pregnant group before pregnancy and the same age range of the pregnant group.

Table 1. Sample characterization – mean, standard deviation (SD) and p value for the variables.

	Pregnant (n = 7)		Non-pregnant(n = 7)		
Variables	Mean	SD	Mean	SD	p
Age (years)	30.43	± 2.15	32.00	± 3.27	0.309
Height (m)	1.63	± 0.06	1.63	± 0.03	0.886
Body mass before pregnancy/non-pregnant	58.64	± 6.68	58.11	± 6.68	0.886
BMI before pregnancy/ Non-pregnant (kg*m-2)	21.93	± 2.13	21.72	± 1.91	0.843

Note: BMI – body mass index; *p< 0.05.

Inclusion criteria for both groups were familiarity with the water environment, $\dot{V}O_2$ found in the first ventilatory threshold between 9ml.kg^{-1}.min^{-1} and 22ml.kg^{-1}.min^{-1}, absence of diseases or use of medication and not being smokers. Both groups signed an informed consent form previously approved by the Ethics in Research Committee of the Federal University of Rio Grande do Sul (2005449).

All subjects performed two submaximal cardiopulmonary tests (with progressive load increase until the point corresponding to the first ventilatory threshold) and two continuous tests. All tests were performed in a cycle ergometer on land and in water respecting a minimum interval of 48 hours and maximum interval of 72 hours between them. Data collection was performed in the swimming Center of the Physical Education School of the Federal University of Rio Grande do Sul.

The participants were told not to perform any kind of physical activity during the period of the tests, not to ingest food three hours before the tests or caffeine 24 hours before them. This control was performed with the aim to avoid interference in the collected variables. Moreover, the participants were familiarized with the Borg's scale (6-20).

The submaximal cardiopulmonary tests with progressive load increase performed in water and land-based environment were performed with the aim to determine the first ventilatory threshold in each of the situations. The tests order was random and the protocol consisted of one minute at 50rpm without load, with subsequent increase of 25 watts at every two minutes. The test was interrupted when the first ventilatory threshold was identified. The tests had duration of six to 10 minutes, with two extra minutes to return to calmness without load still on cycle ergometer. The used protocol in the present study was adapted from Jovanovicet al.[19]. The first ventilatory threshold was identified by three experienced physiologists and was determined through the point at which the ventilatory equivalent to the oxygen (VE/$\dot{V}O_2$) systematically increased, without increase of the ventilatory equivalent to the carbon dioxide (VE/VCO_2)[20]. The HR corresponding to the point in the water and land environment was used as target intensity in the continuous tests.

The continuous tests had duration of 30 minutes each and were performed with the aim to determine the RPE and $\dot{V}O_2$ responses. The exercise started with the individual pedaling for four minutes, without load, at a 50rpm cadence; the load was later increased until the individual reached the HR corresponding to the first ventilator threshold, as found in the progressive test in the corresponding environment. Once the HR was stable, 30 minutes out of the total test time were waited to be completed, and whenever necessary the load was adjusted for maintenance of the target HR; however, velocity was always kept at 50rpm. The exercise measurements consisted of the record of the HR and the $\dot{V}O_2$ at each 20 seconds. The mean of the three measurements of the ninth, 14th, 19th, 24th and 29th minutes were used for the $\dot{V}O_2$ data analysis. At the end of the 30 minutes of the test, the individual showed the RPE in the Borg's scale (6-20). All subjects performed the tests in water at immersion depth close to the xiphoid process level and at water temperature of 32.4 ± 0.37ºC. Room temperature at during the study was 20.8 ± 3.29ºC.

A cycle ergometer was used (Monark – Valburg/Sweden) outside the water connected by a chain to another bicycle (Sculptor – Rio Grande do Sul, Brazil) in water. During all sessions, the respiratory gases were collected by a portable Aerosport KB1-C (Ann Arbor, USA) mixing box gas analyzer. A pneumotach with a neoprene mask was used. The equipment was calibrated according to the manufacturer's recommendations. The gas analyzer was calibrated with known gas concentrations (6% CO_2, 15% O_2) prior to the data collections. An automatic calibration based on the room values was performed between each routine[21]. The HR was monitored by a heart rate monitor through telemetry (POLAR F1, Kajaani, Finland). The $\dot{V}O_2$ and HR data were collected at every 20 seconds. In order to obtain the RPE values, the Borg's scale was used (6-20)[1].

Data were analyzed by descriptive statistics. The dependent variables were tested concerning their normality with the Shapiro-Wilk test and homogeneity of variance by the Levene test. On-way ANOVA for repeated measures with Bonferroni post hoc was used for comparison of the dependent variables in the different experimental situations.The significance level adopted in this study was of α= 0.05. All statistical tests were performed in the statistical program SPSS, version 13.0.

RESULTS

The normality and homogeneity tests results of the $\dot{V}O_2$ and RPE variables justified the use of parametric statistics in the subsequent analysis.

Table 2 demonstrates the mean of the HR values found in the first ventilatory threshold of the submaximal progressive tests, both of pregnant and non-pregnant women who were later used in the continuous tests.

Table 3 shows that significant differences have not been found when the RPE and the $\dot{V}O_2$ between the two states were compared (pregnant and non-pregnant) and between the two environment examples where exercise was performed (water and land). Moreover, there was not significant interaction between the environment and the state.

Table 2. Heart rate response (HR) – mean and standard deviation (SD) – in the progressive test in water ando n land and with pregnant and non-pregnant women.

	Pregnant (n = 7)				Non-pregnant(n = 7)			
	Land		Water		Land		Water	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
HR (bpm)	129.43	± 10.39	127.86	± 3.58	123	± 9.45	123.43	± 6.02

Table 3. Descriptive response of the RPE and VO_2 – mean and standard deviation (SD) – main effect (environment and state) and interaction (state * environment).

Variable	Environment	Pregnant (n = 7)		Non-pregnant (n = 7)		State	Environment	State * environment
		Mean	SD	Mean	SD			
RPE	Land	12.86	±0.90	13.14	±0.90	0.492	0.504	0.822
	Water	13.00	±1.29	13.43	±1.27			
VO2 (l.min-1)	Land	0.79	±0.10	0.80	±0.18	0.689	0.367	0.725
	Water	0.74	±0.16	0.78	±0.10			

Note: RPE –rate of perceived exertion; VO2 – oxygen consumption; *p< 0.05.

In figure 1 we can observe that the mean values of RPE were 12.86 and 13.43, which corresponds in the Borg's Scale (6-20) to exertion level. Additionally, we observe that neither the individual's state nor the environment in which the exercise was performed boosted the RPE results.

Figure 2 demonstrates that the $\dot{V}O_2$ mean in the first ventilatory threshold was between 0.70L.min^{-1}and 0.80L.min^{-1}. Furthermore, the $\dot{V}O_2$ values were not different between the two states or between the two environment in the study.

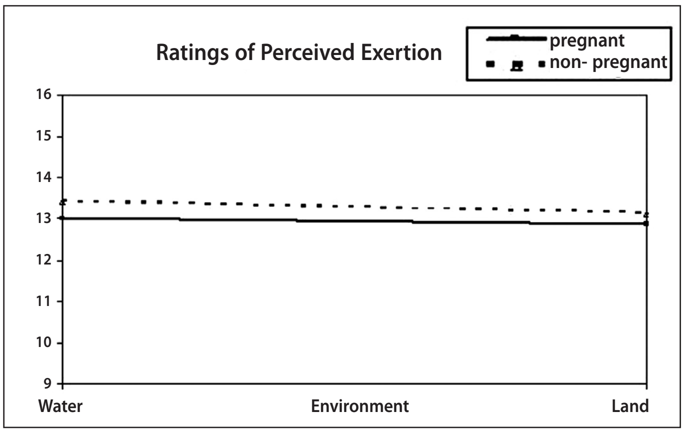

Figure 1. RPE behavior expressed by the mean in the water and land-based exercises performed by pregnant and non-pregnant women.

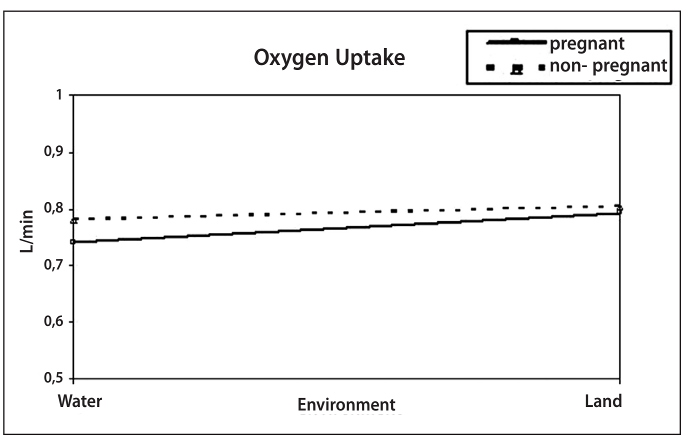

Figure 2. VO_2 behavior expressed by the mean in the water and land-based exercise performed by pregnant and non-pregnant women.

DISCUSSION

The aim of the present study was to assess if there are differences between the RPE and $\dot{V}O_2$ behavior during exercise performed in water or on land, at intensity corresponding to the first ventilatory threshold between pregnant and non-pregnant women. Our results indicated that there were not significant differences in the RPE and $\dot{V}O_2$ between pregnant and non-pregnant women and between exercise performed in water and on land.

Similar results of $\dot{V}O_2$ and RPE responses between the water and land environment were found in the literature with non-pregnant women[16,22-24]. These authors did not find differences in the RPE in exercises performed both in and outside water, demonstrating hence that the RPE may be a consistent indicator of the intensity level and also an efficient index for exercise prescription on land and in water. Graef and Kruel[25], in a literature review, also suggest that the Borg's scale seems to be a reliable and practical option due to the possibility of correspondence between their indices in and outside water, at the same exertion intensity. Concerning the $\dot{V}O_2$ results, two studies[22,23] did not present significant differences either during continuous aerobic exercise between the two environment examples here.

In the present study, the exercise intensity was regulated by the HR corresponding to the first ventilatory threshold through a progressive test in both environment types; this fact may have result in similar responses of RPE between environment types, since the intensities were based on the specificities of each one.

Regarding the RPE and $\dot{V}O_2$ responses between pregnant and non-pregnant women, our data are according to the ones from the review by Wolfe and Weissgerber[26]. In this review, studies between 1966 and 2003 which approached physiological responses of exercises with pregnant women and exercise prescription for this population were used. It was concluded that the RPE is not altered by pregnancy; thus, the Borg's scale may be recommended for prescription of the exercise intensity during pregnancy.

The use of RPE for determination of exercise intensity during pregnancy is questioned in the study by O'Neill et al.[18], where the authors state that during pregnancy many physiological variables, which influence the exertion perception, are altered. In that study, five groups of pregnant women, who performed different types of land-based exercises, at different gestational ages and in the post-partum, were analyzed. They did not find significant correlation between RPE and exercise HR. The HR expected by the perceived exertion was underestimated by the exercise HR in the second trimester of pregnancy during walks, aerobic classes and in circuit training, and in the third trimester during exercise in cycle ergometer and also in the aerobic classes. However, it should be considered that in this study, the authors used the first studies developed by Borg where it is stated that the RPE multiplied by 10 would correspond to the HR expected by the exertion rating as grounding. Nowadays, thanks to new studies it is known that the RPE is related to the physiological loads and not to the exercise HR.

Davies et al.[10] performed a case study with a woman expecting twins.The test was performed on a treadmill on land, and as result RPE higher during the 29th week of pregnancy was found compared with 10 postpartum weeks. Another study[13] assessed 10 pregnant women who performed step exercises in the first, second and third trimesters of pregnancy and for the control group used six non--pregnant women. The RPE was measured at the light, moderate and strong exercise intensities. As results, they did not find RPE variation between trimesters, but it was high when compared with the control group of non-pregnant women.

These mentioned studies clash with the results in the present study in which difference in the RPE were not found when the pregnant and non-pregnant states were compared.The first study mentioned[10] was a case study of a woman expecting twins and its results cannot be extrapolated for a one-baby pregnancy. Another important aspect is related to the different types of exercise assessed in the mentioned studies. The physiological responses are different if an exercise in which the individual does not need to sustain body weight, such as exercise in cycle ergometer used in the present study, and an exercise which body weight needs to be sustained, as exercise on treadmill are compared[8]. Concerning this issue, Pivarnik et al.[11] compared the exercise RPE in cycle ergometer and treadmill. Significant difference between gestational period and postpartum in exercise performed in cycle ergometer was not found; however, during exercise on treadmill, higher RPE during pregnancy than postpartum was found. Probably, these results have occurred due to the differences of the physiological responses of the two types of exercise, since the body weight of the athlete affects the physical activity performance.

The exercises which present more similar physiological responses amongst pregnant and non-pregnant women are the ones which do not require body weight sustaining, such as exercise in cycle ergometer or even water activities, which by their floating effect decrease the hydrostatic effect, reducing stress on the joints which support body weight[27], and overweight derived from pregnancy ends up in not influencing this much the exercise physiological responses. Another important point is to define the metabolic demand of both types of exercise. In the exercise in cycle ergometer, the $\dot{V}O_2$ can be expressed in absolute values ($L.min^{-1}$), since it is independent from the subject's weight, while in exercises in which the individual needs to sustain body weight (treadmill), it is closely related with her body weight[11] and is expressed in relative values ($ml.kg^{-1}.min^{-1}$). Since during pregnancy the woman's weight increases as the fetus develops, it is more suitable to use the $\dot{V}O_2$ expressed in absolute values to avoid this overweight influence on her $\dot{V}O_2$ values or on her physical fitness level.

McMurray et al.[28] compared the metabolic responses in different gestational ages (15^{th}, 25^{th} and 35^{th} weeks) and in postpartum(8-10 weeks) in exercise in cycle ergometer in water. The exercise intensity was kept at 60% of expected HR_{max}. The authors found similar $\dot{V}O_2$ values on the 15^{th} and 25^{th} gestational weeks and in postpartum, since on the 35^{th} week the result presented lower values. This result was caused by the lower work rate performed by the pregnant women in the last trimester, since they could not keep the same exercise intensity during the 20 minutes of the test. These results corroborate the present study where statistically different values have not been found between the exercise performed in the gestational period and in postpartum, considering that the pregnant women of the present study were able to maintain the exercise intensity during the entire proposed time. However, another study[29] found a small difference in the $\dot{V}O_2$ during exercise in cycle ergometer when compared the gestational period with the postpartum period; nevertheless, the authors had the mean of all results obtained during pregnancy instead of analyzing each period. Thus, lower values at the end of the pregnancy can have been observed, as in the study by McMurray et al.[28], and these values on their turn influenced on the comparison between the gestational period and the postpartum period.

As far as we know, there are no studies in the literature which assess the RPE and $\dot{V}O_2$ responses comparing pregnant and non-pregnant women during exercise in cycle ergometer performed on land and in water. Thus, our data contribute to better understand the RPE and $\dot{V}O_2$ responses in this type of exercise and during this gestational period.

It should be mentioned that our study presents some limitations. The HR was chosen as a variable to control exercise intensity due to its practical applicability in the places where the pregnant women practice their physical activities. The results found in the present study cannot be extrapolated to the entire gestational period, since the tests were performed in a single pregnancy period. Finally, a relatively small sample "n" was tested, but the sample was as homogeneous as possible.

CONCLUSION

According to our results significant differences have not been found when the RPE and $\dot{V}O_2$ between the two states (pregnant and non-pregnant) and between the two environment examples in which the exercise was performed (water and land) were compared.

As a practical application, we suggest that the RPE represents a good indicator for physical exercise prescription for pregnant women in their last gestational trimester, both in water and on land, especially when exercise is performed at intensity corresponding to the first ventilator threshold and in cycle ergometer. It should nevertheless be highlighted that the adequate use of the Borg's scale requires suitable guidance and training as well, since lack of familiarity with the instrument may affect the results of the perceived exertion[25].

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

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