Phisiological changes on indoor cycle

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ABSTRACT: Not much is known about the behavior of physiological parameters based on cadence (rpm) and workload (kg) in an indoor cycle class, which are essential for the safety of its practitioners. This study aims to assess physical exertion, which will be measured according to pedaling cadence (rpm) and/or workload (kg) in each phase of an indoor cycle class, and its correlation with the physiological changes of blood pressure (BP), oxygen uptake (VO2), ventilatory rate (VE), carbon dioxide output (VCO2), respiratory exchange ratio (RER), metabolic equivalent term (MET) and body temperature and with Borg Rating of Perceived Exertion. It is characterized as descriptive research, with pre-experimental model using the correlational method of variables. The sample was limited to 15 male practitioners of indoor cycle ranging from 21 to 38 years old (X = 31.8 ± 5.14) selected by the criteria of inclusion and exclusion. With the aim to characterize the different stages of the protocol class of indoor cycle, the cadence (rpm), the workload (kg), the Borg Rating of Perceived Exertion and the physiological parameters BP, VO2, VCO2, VE, RER, MET and body temperature were monitored during 30 minutes of class. After obtaining these data, descriptive statistics were used in order to characterize the sample analyzed based on the selected variables of continuous and discrete nature. To verify the hypotheses mentioned, techniques of inferential statistics were used: kurtosis, for verification of the homogeneity of the sample; Pearson, Anova one way, Tukey tests were performed for the correlation between the analyzed variables; and the "r" distribution to identify the correlation and significant differences. The present study confirms that there is a significant correlation (p<0.05) for the Borg rating of perceived exertion and the physiological parameters systolic BP, VO2, VE, MET when measured based on the workload (kg) and/or cadence (rpm) in each phase of the class, not existing significant changes on VCO2, diastolic BP, body temperature and RER when correlated only with cadence (rpm). It is recommended that research be done comparing physiological changes caused by the class strategies 2nd standing position and 3rd standing position, since there are significant biomechanical differences on the positioning of the body on the bicycle. And also research on the effects of the training of the protocol class described here concerning the physiological parameters examined with the goal to analyze the enhanced physical conditioning through the test of VO2 max on individuals practicing indoor cycle.

Keywords: Ciclismo Indoor, Consumo de oxigênio.

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RESUMEN

Cambios fisiológicos en una sesión de indoor cycle

Poco se conoce sobre el comportamiento de los parámetros fisiológicos en función de la cadencia (rpm) y la resistencia (kg) en una sesión de indoor cycle, que son esenciales para la seguridad de los practicantes. El presente estudio tiene por objetivo la verificación del esfuerzo físico que será medido de acuerdo con la cadencia de la pedalada (rpm) y/o la resistencia (kg) en cada etapa de un sesión de indoor cycle y su correlación con los cambios fisiológicos de presión arterial (PA), consumo de oxígeno (VO₂), ventilación de los pulmones (VE), dióxido de carbono exhalado (VCO₂), cuociente respiratorio (RER), tasa de metabolismo (MET) y temperatura corporal y también con la Escala Borg de Esfuerzo Subjetivo. Se caracteriza como pesquisa descriptiva, con un modelo pré-experimental utilizando el método correlacional de variables. La muestra se limitó a 15 practicantes varones de indoor cycle con rango de edad 21-38 años (X = 31.8 ± 5.14) elegidos según los criterios de inclusión y exclusión. Con objetivo de caracterizar las diferentes etapas de la clase protocolo de indoor cycle, la cadencia (rpm), la resistencia (kg), la escala Borg de esfuerzo percibido y los parámetros fisiológicos PA, VO₂, VCO₂, RER, MET y temperatura corporal fueron monitorados por 30 minutos de clase. Una vez obtenidos los datos, se hicieron estadísticos descriptivos para caracterizar la muestra examinada en función de las variables seleccionadas de naturaleza continua y discreta; para verificar las hipótesis mencionadas, se utilizaron técnicas de estadística inferencial: curtosis, para verificación de la homeogeneidad de la muestra; para correlación entre las variables analizadas, utilizamos r de los tests de Pearson, Anova one way, Tukey para correlación entre las variables analizadas; y la distribución “r” para identificación de las correlaciones y diferencias significativas. El presente estudio confirma que hay una correlación significativa (p<0,05) para la escala Borg de esfuerzo percibido y los parámetros fisiológicos PA sistólico, VO₂, VE, MET cuando mensurados con base en la resistencia (kg) y/o cadencia (rpm) en cada etapa de la clase, y que no existen cambios significativos en VCO₂, PA diastólico, temperatura corporal y RER cuando correlacionados solamente con la cadencia. Se recomienda que se haga una pesquisa comparativa entre los cambios fisiológicos causados por las estrategias de clase segunda posición de pie y tercera posición de pie, ya que existen diferencias biomecánicas significativas según la posición del cuerpo en la bicicleta; y también pesquisa sobre los efectos del entrenamiento de la clase protocolo en función de los parámetros fisiológicos examinados con el objetivo de analizar el aumento del acondicionamiento físico por medio del test de VO₂max en individuos que practican indoor cycle.

Palabras clave: Indoor cycle, Consumo de oxígeno.
popularity of physical activity and body awareness, and thus give support to the fitness fad that was consolidated in the 90’s.

The use of aerobic exercise machines on health clubs became mandatory, based on extensive research reporting their benefits for the improvement of aerobic capacity, reduction of body fat and of the probability of cardiovascular diseases.

Indoor cycling appeared as a new alternative of aerobic activity in health clubs, through a continuous or interspersed training, aiming to maintain and improve the cardiovascular system.

The popularity of indoor cycling is linked with the kinesthetic experience of pedaling on an outdoor environment, where the movements of trekking are simulated and the technique of visualization is used to create a virtual highway, motivating the practitioners. Besides that, indoor cycle is an extremely efficient way to be part on an aerobic training program on a very hectic weekday, regarding the fact that, within 30 to 45 minutes, on average, one can develop a good activity, with significant cardiovascular changes. (POLLOCK, GAESSER, BUTCHER et al, 1998)

The indoor cycle class has the same characteristics of other existing class types in health clubs (local gym, step, aeroboxing), i.e. classes in heterogeneous groups – individuals of different age groups and physical conditioning levels. (MACEDO & OSIEEKI, 2000)

In the last five years, the popularity of indoor cycling rose abruptly in health clubs, but the control of the various training stimuli on different stages of the indoor cycle class is still poor. (MELLO, CARVALHO & DANTAS, 2000)

Not much is known about the behavior of some physiological parameters which are essential for the control of the exertion intensity in a class, for example, the heart rate and oxygen uptake, which causes insecurity to practitioners and, especially, to professionals who deal with this activity.

Not knowing the behavior of the physiological parameters during an indoor cycle class makes it difficult to control the workload correctly; as a result, it is only by chance that they do not reach subtraining – using insufficient workload to cause the desired conditioning effects – or overtraining – using excessive workload with the risk of producing exhaustion and damage.

The lack of studies about the subject raises constant questioning, not only within the academic community but also among Physical Education professionals, especially in Fitness, regarding the validity, efficiency and risks of that class on practitioners of physical activity.

So, the efficiency and effectiveness of the method will be jeopardized, as well as the impact of it among practitioners of indoor cycle.

**METHODOLOGY**

**Study model**

The investigation is characterized as descriptive research, the model being classified as a pre-experimental study structured on the correlational analysis method. According to THOMAS & NELSON (2002) the current study is limited to a pre-experimental research due to the inexistence of a control group and observations determined in the after-test stage.

**Sample selection**

The non-probabilistic sample is limited to individuals with the age of 21-38 years old (X= 31.8 ± 5.14), of male gender, comprising a total of 15 practitioners of indoor cycle in a health club: Academia da Praia, located at Av. Erico Veríssimo n. 400, Barra da Tijuca, west zone of Rio de Janeiro.

This group was chosen for their easy adherence to the process (indoor cycle class) and for controlling the intervention mechanisms (indoor cycle instructors) of indoor cycle practitioners of the selected gym club on the west zone of the city Rio de Janeiro.

**Inclusion and exclusion criteria**

Subjects included in the sample were practitioners of indoor cycle during at least 6 months of activity and a weekly frequency of 3 to 5 times, all of them being apparently healthy (ACSM, 1998) and volunteering to be part on the research by signing the consent form.

Subjects excluded from the sample were those who were using medications and/or nutritional ergogenic resources, and also those who did not agree with the limitations of life and food habits recommended in the 40 hours preceding the study.

**Procedures for data collection**

The present study was done in a single stage.

- **Performance of the tests**

Only 5 individuals were analyzed each day, in the morning and in the afternoon, during all workdays, in the Laboratory of the Research Institute of the Center for Physical Capacitation of the Army (CCFEX), located at the Fortaleza São João, Av. Joao Luiz Alves s/n – Urca, RJ.

One week before the test, all volunteered individuals received a protocolled letter informing date and time of the experiment with an attached document with the details of the basic procedures which should be followed on the day before the test and signed a consent form for volunteer participation on the research, explaining the objectives and the protocols of the tests which they would undergo.

- **Variable collection**

The volunteers to the research took part on an indoor cycle class (MELLO, 2002), which is explained in details on table 1.

In order to characterize the several stages of an indoor cycle class, the cadence (rpm), the workload (kg), Borg’s Rating of Perceived Exertion and the physiological parameters PA, VO₂, VCO₂, VE, RER, MET, body temperature were monitored during 30 minutes...
of class, except for PA and body temperature, which were checked on the intervals 13/20/28 minutes of the test.

The bicycle used was adjusted according to the individual analyzed and all the equipment used during the test were checked and gauged before each collection.

To verify the homogeneity of the sample, the following measures were obtained: age and gender, weight and height (FERNANDES, 1999). The body fat percentage was calculated according to Pollock’s 3-skinfold protocol (POLLOCK & WILMORE, 1994). Also an anamnesis was performed and the questionnaire Par-Q was used.

**Protocols used**

In order to perform the study, the use of the following protocols was necessary:

- Bicycle adjustment (REEBOK UNIVERSITY, 1997):
  - Seat height adjustment – the individual should put him/herself seated on the bicycle with the feet parallel to each other with an imaginary line on the front face of the patella with the central axe of the pedal.
  - Handlebar height – the handlebar should be on the same height as the seat.

- **Variable collection**

The cadence (rpm) was collected through a cycle computer attached to a bicycle, and the workload (kg) was regulated with the addition of 1kg discs.

Borg’s Rating of Perceived Exertion was collected with the help of a table attached close to the bicycles through figures representing the degree of perceived subjective exertion.

The PA was checked through a sphygmomanometer of mercury column. The tensiometer (cuffs) was attached to the left arm next to the elbow.

For VO$_2$, VCO$_2$, VE, RER and MET, after the gauging of the instrument, the equipment (silicon mask or nozzle with nasal clip) was attached. The equipment was connected to the instrument where they were analyzed.

The body temperature was checked with the help of a digital ear thermometer inserted to the left ear.

* All the variables were checked every minute, on a maximum period of 5 seconds, with the exception of the PA and the body temperature, which were checked on the periods 13/20/28 minutes of class.

- **Indoor cycle class**

The protocol used (MELLO, 2002) had the duration of 30 minutes based on the studies of WILMORE & COSTILL (2002), ACMS (1998) and on official reports of the SURGEON GENERAL US (1996), which determine the duration of exercises for improving the cardiovascular system.

According to the official report of the US DEPARTMENT OF HEALTH AND HUMAN SERVICES – SURGEON GENERAL REPORT (1996), Physical Activity and Health, the added benefits to health may be obtained by higher quantities of physical activity with activities of longer duration or greater intensity.

<table>
<thead>
<tr>
<th>TESTS</th>
<th>Height</th>
<th>Body Weight</th>
<th>Age</th>
<th>% F</th>
<th>LBM</th>
<th>BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test 01</td>
<td>1.67</td>
<td>74.20</td>
<td>33.00</td>
<td>14.02</td>
<td>63.80</td>
<td>26.61</td>
</tr>
<tr>
<td>Test 02</td>
<td>1.67</td>
<td>70.30</td>
<td>31.00</td>
<td>18.52</td>
<td>57.28</td>
<td>25.21</td>
</tr>
<tr>
<td>Test 03</td>
<td>1.83</td>
<td>83.70</td>
<td>37.00</td>
<td>15.97</td>
<td>70.33</td>
<td>25.08</td>
</tr>
<tr>
<td>Test 04</td>
<td>1.75</td>
<td>80.70</td>
<td>33.00</td>
<td>16.55</td>
<td>67.34</td>
<td>26.35</td>
</tr>
<tr>
<td>Test 05</td>
<td>1.80</td>
<td>82.70</td>
<td>32.00</td>
<td>15.61</td>
<td>69.79</td>
<td>25.52</td>
</tr>
<tr>
<td>Test 06</td>
<td>1.88</td>
<td>99.60</td>
<td>31.00</td>
<td>19.03</td>
<td>80.64</td>
<td>28.18</td>
</tr>
<tr>
<td>Test 07</td>
<td>1.72</td>
<td>74.30</td>
<td>33.00</td>
<td>14.52</td>
<td>63.51</td>
<td>25.03</td>
</tr>
<tr>
<td>Test 08</td>
<td>1.83</td>
<td>78.50</td>
<td>21.00</td>
<td>5.90</td>
<td>73.87</td>
<td>23.57</td>
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<tr>
<td>Test 09</td>
<td>1.75</td>
<td>76.80</td>
<td>35.00</td>
<td>8.13</td>
<td>70.56</td>
<td>25.05</td>
</tr>
<tr>
<td>Test 10</td>
<td>1.75</td>
<td>70.00</td>
<td>30.00</td>
<td>18.05</td>
<td>57.37</td>
<td>22.99</td>
</tr>
<tr>
<td>Test 11</td>
<td>1.81</td>
<td>72.90</td>
<td>36.00</td>
<td>20.55</td>
<td>57.92</td>
<td>22.25</td>
</tr>
<tr>
<td>Test 12</td>
<td>1.87</td>
<td>97.90</td>
<td>37.00</td>
<td>18.15</td>
<td>80.13</td>
<td>28.00</td>
</tr>
<tr>
<td>Test 13</td>
<td>1.77</td>
<td>90.80</td>
<td>29.00</td>
<td>28.63</td>
<td>64.80</td>
<td>28.98</td>
</tr>
<tr>
<td>Test 14</td>
<td>1.82</td>
<td>84.50</td>
<td>21.00</td>
<td>15.97</td>
<td>71.00</td>
<td>25.51</td>
</tr>
<tr>
<td>Test 15</td>
<td>1.63</td>
<td>70.20</td>
<td>38.00</td>
<td>27.49</td>
<td>50.90</td>
<td>26.52</td>
</tr>
<tr>
<td>Average</td>
<td>1.77</td>
<td>80.47</td>
<td>31.80</td>
<td>17.14</td>
<td>66.62</td>
<td>25.66</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.07</td>
<td>9.56</td>
<td>5.14</td>
<td>5.90</td>
<td>8.48</td>
<td>1.88</td>
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</tbody>
</table>
WILMORE & COSTILL (2002) determined that the ideal duration of the exercise is 20 to 30 minutes, working on the adequate intensity, and that the fundamental is to reach the limit not only of duration but also of intensity.

Based on the ACMS (1998) the duration of the training may vary from 20 to 60 minutes, continuous or interspersed, being strictly linked with the intensity of its performance, since exercises of different duration are guaranteed by different energetic systems.

During an indoor cycle class, the aerobic and anaerobic energetic systems interact according to the duration and intensity of the stimulus and duration and intensity of the determined recovery.

GOMES (2002) classifies the mixed zone (aerobic and anaerobic) according to the physiological criteria heart rate, VO$_2$ max and lactate (mmol/l) percentage, relating them to the maximum duration of the exercise: exercises with a duration of 30 minutes to 2 hours can produce 4-6 mmol/l of lactate and exercises with a duration of 10 to 30 minutes can produce 6-8 mmol/l of lactate.

In a study done by MELLO et al (2000) the amount of blood lactate measured during the class varied from 3.6 mmol/l (9 minutes of activity) to 9.34 mmol/l (35 minutes of activity), the limit (6.60 mmol/l) being reached within 21 minutes of class.

Based on this, the protocol used by MELLO et al (2000) was adapted to the current model.

The training model used was an interspersed one with short rigid recovery intervals which allowed active recovery of the exercise done, knowing that these intervals, established in the protocol, bring to fatigue with the progression of the work.

In cycling, the normal cadence varies from 72 to 102 rpm, low cadence emphasizing power and high cadence emphasizing speed. Ascending normally demands power and cadence varies from 60 to 80 rpm. In speed situations, like in a sprint, the cadence may extrapolate 120 rpm, but the ideal cadence is around 90 rpm (BURKE, 1995; SOEST & CASIUS, 2000).

Based on the information above, it was established in the protocol that the low cadence would vary from 60 to 80 rpm for the 1st seated position and the 2nd standing position, and the high cadence from 80 to 100 rpm only for the 1st seated position.

To determine the workload, research by MARSH, MARTIN & FOLEY (2000) was used, where the preference of cadence with a higher workload (W) was observed on trained cyclists, trained runners and untrained individuals. The conclusion was that trained cyclists and runners preferred a cadence between 92-96 rpm with the workload increasing from 100 to 200 W and untrained individuals preferred a cadence of 69-80 rpm with workload increasing from 75 to 150 W.

Based on this information, the following equation was used according to VADEMECUM (1999):

Taking these data into account, the workload 1kg (≈50 W) was determined for the first 5 minutes of activity with the goal of a specific warm-up, considering it a light workload (W). A workload of 2kg (≈100 W) for the 1st seated position, already established in the literature mentioned above, as the ideal workload for a low cadence and a workload of 4 to 200 W) for the 2nd standing po-
sition, considered on Borg’s Rating of Perceived Exertion as heavy-
very heavy, but determinant for the body support on the bicycle.

**Instruments**

- Maxx Pro bicycle, projected by Dr. Leszek A. Szmuchrowski,
  UFMG.
- Total body weight: a digital scale with 100g precision of the
  brand FILIZOLA model PL150 Personal Line, Brazil, 1999.
- Height: SANNY stadiometer, professional model
- Body fat percentage: CESCORF scientific skinfold calliper.
- Complementary laboratory material: gloves, gauze roller
  bandages, cotton, adhesive tapes.
- Rpm: CATEYE ASTRALE cyclecomputer, made in Japan,
  standard deviation ± 1 rpm according to the Manual of the
  CATEYE ASTRALE model CC-CD 100N validated by Profes-
  sors Frederico Jandre A. Tavares e Luis Gulherme B. Rolim
  (COPPE, UFRJ-RJ, 2001).
- Workload: the regulation of the workload is done with discs
  of 1kg each, total of 8 kg.

**Procedures for Data Analysis**

The present study will observe the basic considerations on statistic
treatment for the maintenance of the scientifcity of the research.

<table>
<thead>
<tr>
<th>Table 2 - Pearson's Correlation Test</th>
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<td>Time</td>
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<td>Time</td>
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<tr>
<td>Load</td>
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<td>MET</td>
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<td>QR</td>
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<td>VE</td>
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<td>VO₂</td>
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</table>
The significance level considered was $p<0.05$, i.e. 95% certainty for the affirmatives and/or negatives that the present study may indicate. The errors of the estimates will observe the two-sided test limits of the distribution of an average, corresponding to the standard error calculated for a percentile wideness 99% based on the z score (standard normal distribution).

The statistical treatment will constitute of two parts, the first related to descriptive statistics, in which the techniques of descriptive statistics will be used to characterize the analyzed sample in function of the selected variables. For those of continuous nature, i.e. which follow a well-defined metrical system, the average, standard deviation, variance, total amplitude and kurtosis will be used in order to understand the homogeneity of the sample and the dispersion level to analyze the symmetry of the frequency distribution under a normal curve. For the discrete variables, the frequency distributions will be used, regarding absolute values and their respective relative values.

The second part will be that related to inferential statistics, with which the hypotheses will be tested (Anova – Analysis of Variance) which will constitute the basis of the comparative process of the average values calculated, based on the discrete variables considered. Once the Anova one way test is used, the Tukey tests will be used, when the sizes of the samples are equal, commonly used in the intra-analysis – within the group for different extracts – and also the distribution test t, in order to understand the significance of the Pearson’s correlation coefficient $r$. With these approaches, where the differences and correlations are significant, one will be able to identify where the referred differences are shown, the denoted magnitude and the functional relations existing in the process.

Taking into account that each experimental variable observes a value scale quantified by measurement units and particular independent magnitudes and that they have been observed and tabulated within a temporal series, in which the observation process was structured, it has been observed that the data normalization, having as a basis (100%) the first observation of the variable analyzed would imply that all variables would follow the same numeric scale and of similar magnitude, allowing that we also perform the functional temporal comparative process of the experimental variables.

RESULTS

After collecting and organizing the net results obtained, the results of height, age, total body weight, fat percentage, lean body mass and Body Mass Index (BMI) can be see on the following table.

<table>
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<tr>
<th>Table 3 - Discretionary variable = Time</th>
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<tr>
<td>Time</td>
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<td>28 min.</td>
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<td>30 min.</td>
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</tbody>
</table>

The numbers correspond to the score of ascending order of the average values
The individuals analyzed presented an average BMI 25.66 ± 1.88, with a minimum BMI value = 22.25 and maximum BMI value = 28.98. These values are in the normal standard since all individuals presented a lean body mass (LBM) extremely high, which influenced the final result, since the equation refers to the total body weight (kg) divided by height (2).

For most adults, there is a clear correlation between a high BMI and the negative consequences to health. A healthy BMI varies from 19 to 25 kg/m², and values above 27 kg/m² are directly associated to cardiopathy. Therefore, individuals analyzed here meet normal standards.

If every individual were different, the probability of having different responses would be great. If every individual is similar, there is a probability that the results are similar, unless the treatment (MELLO protocol, 2002) has generated different responses. (ALBERGARIA, 2002).

**Presentation of collected data**

The oscillations of average VO₂ were 1.25 L O₂/min ± 0.23, minimum average value achieved in the 5th minute and 2.84 L O₂/min ± 0.42 achieved in the 24th minute of test. Following the oscillations of oxygen uptake, we observe a tendency to increase along the activity and a correlation between these changes and the changes of rpm of 0.65. However, when we analyze them in relation to the higher workload, there is no correlation.

The results presented above prove that there is no significant correlation p<0.05 of VO₂ with the workload and/or rpm, taking into account that VCO₂ presents a progressive linear increase based on the increased intensity of the class, although not significant.

The PAS increases progressively until 13 minutes of activity (15.1mmHg ± 2.3), is stable at 20 minutes (14.5mmHg ± 1.2), where it starts to drop gradually (due to the steady state within 16 minutes of class), achieving at the end of the last stimulus 13.6mmHg ± 1.1.

The PA could drop gradually when the steady state occurs, due to the arteriolar dilatation on active muscles, shortening the total peripheral resistance. (WILMORE & COSTILL, 2002; MCARDLLE et al, 1998)

On the other hand, the diastolic PA changes little, regardless of the intensity of the exercise. The increased VE in the first minutes of the class is related to the mechanics of the movement, the increased body temperature and the biochemical condition of the arterial blood. During a maximum respiratory exertion, during an exhausting exercise, the inhalation can reduce the intralung pressure from 80 to 100mmHg (at rest this value is as high as 3mmHg) (WILMORE & COSTILL, 2002). After 20 minutes of class, there is a significant increase of VE (87.1mmHg ± 16.1) achieving the peak (98.8mm Hg ± 24.3) at 28 minutes of class, making evident the ventilatory breaking point at 20 minutes of activity (19 minutes=78.5 mmHg ± 10.9 / 20 minutes = 87.1mmHg ± 16.1), explained by the behavior of the VO₂, which remains stable (2.8 l/min ± 0.3), reflecting the organic need of removing the excess of VCO₂.

The RER varies according to the substrate used for producing energy. (WILMORE & COSTILL, 2002). According to the results presented (RER= 1.1 ± 0.1), the energy used in an indoor cycle class is exclusively from glucose or glycogen, generating from every liter O₂ consumed 5.05 kcal, estimating thus an energy production of 350kcal/min.

The maximum MET achieved occurred at 24 minutes of class (9.8 ± 2.3), nearly 10 times the metabolic rate at rest, equivalent to an oxygen uptake value of 3.5 ml/kg-1. min-1. Analyzing tables of activities and their values in MET (MCARDDLE et al, 1998 & WILMORE & COSTILL, 2002), it was verified that the cycling activity, with a speed of 20.9 km-h, has a metabolic rate of 9 MET, reinforcing the class protocol used for the indoor cycle class.

The results presented for body temperature prove that there is no significant correlation p<0.05 for body temperature with the workload and/or rpm, since the body temperature had very little change, thus not significant, remaining on a constant range of 36.1 to 37.8° C, meaning an effective performance of the temperature-regulating center.

The Exertion Rating presents a continuous, linear progression based on the increased intensity of the class. According to BORG (2000) the scale for assessing the perceived exertion has a basic supposition that the physiological tension increases linearly with the intensity of the exercise, and that the perception should follow the same linear increase. Therefore, we confirm that there is a significant correlation p<0.05 of the Borg Rating of Subjective Exertion with the increased intensity of the class with the change of workload and/or rpm.

**Presentation and Discussion of the Statistic Hypotheses Tests**

We now come to the second part of the statistic treatment referring to the inferential approach, which will be the basis for the

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**Table 4 - Discretionary variable = Workload**

<table>
<thead>
<tr>
<th>g.l</th>
<th>F</th>
<th>Sig p</th>
<th>Workload</th>
<th>MET</th>
<th>RER</th>
<th>VE</th>
<th>VO2</th>
<th>VCO2</th>
<th>WKLOAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/371</td>
<td>42.122</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

---

**Table 5 - Discretionary variable = Rpm**

<table>
<thead>
<tr>
<th>RpmBn</th>
<th>RpmAn</th>
</tr>
</thead>
<tbody>
<tr>
<td>MET</td>
<td>-0.14</td>
</tr>
<tr>
<td>RER</td>
<td>0.03</td>
</tr>
<tr>
<td>VE</td>
<td>-0.19</td>
</tr>
<tr>
<td>VO2</td>
<td>-0.13</td>
</tr>
<tr>
<td>VCO2</td>
<td>-0.11</td>
</tr>
<tr>
<td>WKLOAD</td>
<td>0.12</td>
</tr>
</tbody>
</table>
hypothesis testing. For that matter two tests have been used. The first was Pearson’s correlation test to verify the possible relations of proportionality in the values representing the experimental variables. The results are as seen in the matrix below:

The results above confirm what had been previously observed in a heuristic analysis, i.e. there is a functional relation with high significance ($r>0.90$) in the variables MET, VE, VO$_2$, and VCO$_2$. The lowest correlations calculated are within the crossing with the variable RER. Still, for the variables time and workload, we have the following observations:

All the experimental variables presented high correlation with the factor time and with characteristic denoted in direct proportionality, once Pearson’s $r$ coefficients are all positive and higher than 0.70. This result means that the absolute and/or relative values of the respective variables increase proportionately along the observation time;

- Again for the factor workload, the experimental variables presented positive correlation (directly proportional), yet with Pearson’s $r$ coefficient below 0.75. Observe that the variable RER was more sensitive-functional than the other variables for the factor workload, presenting a correlation coefficient $r = 0.714$.

The second moment of inferential statistics refers to the application of variance analysis, associated with Tukey’s post-hoc tests, for the comparison of calculated average values. A standard significance was observed to reject the null hypothesis (equal average values) with $p<0.05$. The results follow as seen in the table below:

From the results of the table above, it is given that there are significant changes (for $p<0.05$) in the average values of the respective time extracts, analyzed according to every experimental variable. All the calculated significance levels are lower than 0.0001. We also observe that at 10 min and 17 min a so-called quantum leap is drawn of the average values, once there is invariably a significant change in the average values for higher in all the variables.

Similar to what has been observed for the discretionary variable time, it is given that for the variable workload, there are also significant differences between the average values of the respective experimental variables based on the workload used. All the variables behaved in a similar way, i.e. for the loads 1 and 2 no significant differences were observed ($p<0.05$), being significantly lower than those calculated for the workload 4.

Table 6 - ANOVA one-way test for the discretionary variable Rpm

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sig</th>
<th>Result</th>
<th>Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>MET</td>
<td>0.0447</td>
<td>Different</td>
<td>A $&gt; B$</td>
</tr>
<tr>
<td>RER</td>
<td>0.6583</td>
<td>Same</td>
<td>A = B</td>
</tr>
<tr>
<td>VE</td>
<td>0.0014</td>
<td>Different</td>
<td>A $&gt; B$</td>
</tr>
<tr>
<td>VO2</td>
<td>0.0467</td>
<td>Different</td>
<td>A $&gt; B$</td>
</tr>
<tr>
<td>VCO2</td>
<td>0.0691</td>
<td>Same</td>
<td>A = B</td>
</tr>
</tbody>
</table>

$A = 60 - 80$ and $B = 80 - 110$

Matching the results of time and workload, we can conclude that both contribute for the variations of average values, observed in experimental variables. We should observe that within 17 minutes, time extract that expresses one of the significant changes in the average values of the variables is when the workload is higher, probably justifying the changes observed.

**Discretionary variable = Rpm**

In order for us to understand the functional relations between the experimental variables and the rpm parameter (high and low), an initial correlational analysis is constituted, with the Pearson coefficient, taking for the crossings the normalized values. The results are as seen on the table below:

From the results above, it is given that the correlations between the experimental variables and the rpm parameter are not significant ($r<0.70$), resulting that, treating the rpm parameter as a continuous variable, we evidence a lack of functional relation. This result indicates that we should treat the rpm parameter as a discretionary variable within an inferential variable, using the ANOVA one way test, in order to compare the average values of each rpm standard so as to truly understand if this parameter infers significantly in the changes observed in the experimental variables.

The results follow as seen in the table below:

**CONCLUSIONS AND RECOMMENDATIONS**

The present study has assessed physical exertion measured in function of pedaling cadence (rpm) and workload (kg) in each stage of the indoor cycle class, confirming that a significant correlation exists for $p<0.05$ for physiological changes of systolic PA, VO$_2$, VE, MET and Borg’s Subjective Exertion Rating. However, there are no significant changes for the variables VCO$_2$, diastolic PA, body temperature and RER when correlated only with rpm.

Due to the conclusion that there is a variation of the systolic PA with the variation of workload (kg) and/or cadence (rpm) in function of the class stage considered on the protocol used, we recommend the control of this physiological parameter in indoor cycle classes due to the different stimuli from varying intensity and restrictions of this activity for people with heart conditions.

The VCO$_2$ presents a progressive linear increase based on the rising intensity of the class, although not significant. The temporal behavior of this variable begins on the lowest level, rises significantly between the interval 0 min to 15 min, after that, we find disperse values until the end of the class, which makes the gas exchange difficult and causes hyperventilation. Previous studies (Mello, 2000) indicate that this hyperventilation may start by increased hydrogen ion concentration because of the production of lactic acid during the test, which is very significant. Based on this information, we recommend the control of this physiological parameter in indoor cycle classes associated with the control of blood lactate levels due to the different stimuli of varying intensity.
In the first minutes of the class there is an increase on VE, which is related to the mechanics of the movement, the higher body temperature and the biochemical condition of the arterial blood. Based on these data, we recommend the control of body temperature with good moisturizing during the class and the control of room temperature with well-ventilated classrooms.

Based on the presented results, the energy used in an indoor cycle class is exclusively from glucose or glycogen, generating from each liter of O2 consumed 5.05 kcal, i.e. an estimated energy production of 350 kcal/min. Consequently, we recommend the control of food ingestion before and after an indoor cycle class.

The body temperature had very little change, indeed not significant, remaining on a constant 36.1 to 37.8°C, meaning an effective performance of the thermoregulating center, even so, the control of body temperature is reinforced with good moisturizing during the class and the control of room temperature with well-ventilated classrooms.

We recommend that a pre-test of maximum oxygen uptake (VO2 max) be done and of the body composition for analysis and determination of the VO2 percentage used during the tests.

We recommend that research be done comparing the physiological changes caused by class strategies 2nd seated position and 2nd standing position, since there are significant biomechanical differences in the position of the body on the bicycle, as well as research on the effects of training of the protocol class described here concerning the physiological parameters observed with the aim to analyze the increased physical conditioning with the VO2 max test on individuals who practice indoor cycle.

REFERENCES


