

Barbado, C.; Foster, C.; Vicente-Campos, D. y López-Chicharro, J. (2017). Intensidad del ejercicio en ciclismo indoor / Exercise Intensity During Indoor Cycling. Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte vol. 17 (67) pp. 481-491. [Http://cdeporte.rediris.es/revista/revista67/artintensidad826.htm](http://cdeporte.rediris.es/revista/revista67/artintensidad826.htm)
DOI: <https://doi.org/10.15366/rimcafd2017.67.006>

ORIGINAL

EXERCISE INTENSITY DURING INDOOR CYCLING

INTENSIDAD DEL EJERCICIO EN CICLISMO INDOOR

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Acknowledgements

We thank GH Sports® and Team ICG® for their support and provision of resources without which this investigation would not have been possible. The authors are also grateful to the sports centers Covibar, Abasota, Palestra, Paidesport Parquesur, Fitnessdromo, Star Gym, Parque del Sureste and El Capricho for their help with the data collection, and to their instructors and members for participating in this study.

Código UNESCO / UNESCO Code: 2411 Fisiología Humana / Human Physiology

Clasificación Consejo de Europa / Council of Europe Classification: 6. Fisiología del ejercicio / Exercise Physiology

Recibido 15 de diciembre de 2014 **Received** December 15, 2014

Aceptado 15 de septiembre de 2015 **Accepted** September 15, 2015

ABSTRACT

The aim of this study was to quantify the intensity linked to an indoor cycling session. 300 healthy experienced subjects performed an indoor cycling session while HR was recorded between minute 1-15 (HRmean1), 16-30 min (HRmean2) and 31 min to the peak intensity of the session (HRmean3). RPE values were obtained at 15 min (RPE15), 30 min (RPE30) and 45 min (RPE45). Mean HR of the session was 144.84 ± 15.59 bpm. HRmean1, HRmean2 and

HR_{mean3} were 135.37 ± 16.50 bpm, 148.84 ± 15.85 bpm, and 153.79 ± 16.66 bpm, respectively. RPE₁₅, RPE₃₀ and RPE₄₅ values were 5.39 ± 1.72 , 7.14 ± 1.34 and 7.14 ± 2.44 , respectively. Bivariate correlations made between HR and RPE values showed significant correlation at 15 ($r=0.336$; $p<0.01$), 30 ($r=0.291$; $p<0.01$), and 45 ($r=0.459$; $p<0.01$) min. These data suggest that indoor cycling can be a vigorous intensity activity.

KEY WORDS: Spinning, cardiovascular, group exercise, bike, fitness.

RESUMEN

El objetivo de este estudio fue cuantificar la intensidad de una sesión de ciclismo indoor. 300 sujetos experimentados realizaron una sesión en la que se registró la FC media entre el minuto 1-15 (FC_{media1}), minuto 16-30 (FC_{media2}), y minuto 31-intensidad pico de la sesión (FC_{media3}). Se obtuvieron valores de RPE en el minuto 15 (RPE₁₅), 30 (RPE₃₀), y 45 (RPE₄₅). La FC media de la sesión fue 144.84 ± 15.59 lpm. La FC_{media1}, FC_{media2} y FC_{media3} fue 135.37 ± 16.50 lpm, 148.84 ± 15.85 lpm, y 153.79 ± 16.66 lpm, respectivamente. La RPE₁₅, RPE₃₀ y RPE₄₅ fue 5.39 ± 1.72 , 7.14 ± 1.34 y 7.14 ± 2.44 , respectivamente. Las correlaciones bivariadas entre la FC y la RPE mostraron correlación significativa en el minuto 15 ($r=0.336$; $p<0.01$), 30 ($r=0.291$; $p<0.01$), y 45 ($r=0.459$; $p<0.01$). Estos datos sugieren que el ciclismo indoor puede ser una actividad de alta intensidad.

PALABRAS CLAVE: Spinning, cardiovascular, ejercicio en grupo, bici, fitness

INTRODUCTION

Indoor cycling, is one of the most popular group exercises practiced at sports and fitness centers. Training is performed to music with an instructor who guides the session towards targets related to the characteristics of the participants. Exercise is mainly cardiovascular, although with a leg muscle strengthening component (1).

Among other factors, heart rate (HR), oxygen consumption (VO₂), or Rating of Perceived Exertion (RPE) can be used as measures of the intensity of aerobic exercise. Unfortunately, monitoring VO₂ during an indoor cycling class requires the use of complex and costly equipment as well as technical expertise. Thus, the methods normally used to control training intensity at most gyms and fitness centers are HR monitoring using pulsometers, often based in age predicting HR_{max} (2) and RPE (3) assessed using different equations or scales. According to Bianco et al.(4), HR and RPE are useful to dose the intensity of indoor cycling within safety margins, thus avoiding overtraining and obtaining maximal benefits.

To adjust the intensity of training during a cycling session, the instructor has several tools: 1) pedaling cadence, directly related to music tempo; 2) breaking

resistance applied by the subject on the bicycle; 3) the position on the bicycle and 4) the ratio at interval to recovery period (5). Few studies have directly assessed the intensity of indoor cycling training and most existing investigations have examined the HR response in a laboratory simulated cycling session (6-11). To date, the largest study addressing indoor cycling training intensity is that by López-Miñarro and Muyor-Rodríguez (3), who determined HR and RPE in 59 novice subjects and only during a single session. More recently Piacentini et al. (12) monitored training intensity in a setting of actual indoor cycling in 15 subjects.

So far, the available data indicate a high exercise intensity during indoor cycling (3, 6-12). Battista et al. (10) demonstrated that HR and VO_2 during indoor cycling could exceed that observed during incremental exercise test. These authors also warned of the risk that such a high intensity of exercise could have for individuals with cardiovascular problems.

HR remains high during most of an indoor cycling session. Battista et al. (10) observed that during more than 10% of a session's duration, HR remained over the rates corresponding to the ventilatory threshold. In addition, Piacentini et al. (12) observed that during 80% of the sessions monitored, subjects showed HR higher than those of the target HR. This suggests that it is difficult for indoor cycling instructors to design programs that target appropriate intensities for each stage of a training session.

The present study was designed to determine the intensity of exercise during several indoor cycling sessions in a large sample of healthy adult subjects.

MATERIAL AND METHODS

SUBJECTS

The subjects were 300 healthy adults, 184 men (age: 41.84 ± 8.24 years; height: 175.04 ± 7.48 cm; weight: 82.05 ± 11.80 kg) and 116 women (age: 39.81 ± 7.61 years; height: 163.12 ± 5.87 cm; weight: 61.47 ± 7.66 kg). Participants had an indoor cycling experience of 3.60 ± 3.32 years and practiced 2.92 ± 1.25 days per week. Subjects were excluded if they had joint, muscle or tendon problems or took any medication that could affect their HR response to exercise. Participants were instructed to avoid caffeine or other stimulants in the 3 h prior to a monitored training session and also to avoid intense exercise in the 24 h before the session. Written informed consent was obtained from each subject. The study protocol received approval from the University Institutional Review Board.

PROCEDURES

Age predicted HRmax was calculated for each subject using the equation "Theoretical HRmax = $220 - \text{age}$ ", (13) and the following four training intensity

zones defined: zone 1, less than 70% HRmax; zone 2, 70 to 89% HRmax; zone 3, 90 to 100% HRmax; and zone 4, over 100% HRmax.

All subjects were weighed in their sportswear (t-shirt and cycling pants or shorts) at the beginning and end of each cycling session. Ingested fluids were recorded by weighing individual bottles before and after each session. Sweat volume was estimated from the change in body mass corrected for the volume of fluid ingested (14, 15). The temperature (°C) and humidity (%) of the training studio were also measured at the start and end of each session.

The data analyzed were obtained in 39 sessions performed by a mean of 7.71 ± 3.43 subjects per session. Mean session duration was 46.46 ± 2.41 min. The sessions were guided by 16 instructors certified by different fitness schools and were conducted in the setting to which the subjects were accustomed (same timetable, same room, same instructor). No instructions were issued as to how each instructor should undertake each session and subjects were blind to their HR data. Water or sports drinks could be consumed *ad libitum*.

During sessions, HR was recorded using radiotelemetry for groups. Recording commenced at the start of each session and finished as soon as the instructor requested the subjects to stop pedaling. No recording was conducted during the stretching stage at the end of a session. During HR monitoring, partial mean HR values were determined from the start of a session to 15 min (HRmean1), from 16 to 30 min (HRmean2) and from 31 min to the last HR peak in the session (HRmean3).

The session rating of perceived exertion was determined using the *OMNI* scale validated for cycling (16). Before the sessions, subjects were informed of how to use and interpret the *OMNI* scale and recommendations for its use were read out loud. A card with the scale and a marker were hung from the bike handle so that RPE scores could be recorded by each subject at minutes 15, 30 and 45 of each session without having to stop pedaling or get off the bicycle.

STATISTICAL ANALYSIS

Descriptive statistics were used to determine mean HR and RPE values in the recorded data for the 300 subjects both for a whole session and within sessions, along with the mean time spent in each training zone. Correlation between HR and RPE was determined using a bivariate relation between continuous variables to obtain a Pearson correlation coefficient (17).

RESULTS

The mean overall HR obtained for the session was 144.84 ± 15.59 bpm, corresponding to $80.95 \pm 8.30\%$. Significant differences were observed in the HR response recorded for the different periods in a session (Table 1).

The times spent in each training intensity zone are provided in Table 2.

Table 1. Mean HR for each period in a session

	Mean HR (bpm)		% predicted HRmax	
	Mean	SD	Mean	SD
Complete session	144.84	15.59	80.95	8.30
HRmean1	135.37**	16.50	75.68**	8.87
HRmean2	148.84**	15.85	83.21**	8.46
HRmean3	153.79**	16.66	85.95**	8.72

HRmean1: mean HR at 15 min. HRmean2: mean HR from 16 to 30 min.
 HRmean3: mean HR from 31 min to the last intensity peak for the session.

** p<0.01 versus remaining times

Table 2. Time spent in each HR zone

	Time (min)	
	Mean	SD
T1	8.49	9.85
T2	26.92**	11.19
T3	9.37	9.56
T4	1.65**	5.19

T1: Time <70% predicted HRmax. T2: Time 70-89% predicted HRmax. T3: Time 90-100% predicted HRmax.
 T4: Time >100% predicted HRmax.

**p<0.01 versus remaining zones

Lower session RPE scores were recorded (p<0.01) at 15 min (5.39 ± 1.72; somewhat easy- somewhat hard) compared to 30 min (7.14 ± 1.34; somewhat hard-hard) or 45 min (7.14 ± 2.44; somewhat hard-hard). No significant differences (p>0.05) were detected between the time points 30 min and 45 min. There were significant correlations (p<0.01) between RPE and HR at all 3 time points (15, 30 and 45 min), both for absolute (bpm) and relative HR (% theoretical HRmax) values (Table 3).

Table 3. Correlation between HR and RPE

	RPE15 - HR15 (bpm)	RPE30 - HR30 (bpm)	RPE45 - HR45 (bpm)
Pearson's r	0.336**	0.291**	0.459**
Sig. (bilateral)	0.000	0.000	0.000
N	300	300	300
	RPE15 - HR15 (%predicted HRmax)	RPE30 - HR30 (%predicted HRmax)	RPE45 - HR45 (%predicted HRmax)
Pearson's r	0.324**	0.275**	0.464**
Sig. (bilateral)	0.000	0.000	0.000
N	300	300	300

RPE15: RPE at 15 min, RPE30: RPE at 30 min, RPE45: RPE at 45 min, HR15: HR at 15 min, HR30: HR at 30 min, HR45: HR at 45 min.

**p<0.01

When weight-related and environmental factors were considered, we observed that mean fluid intake for the whole study population for a session was 366.24 ± 216.08 ml, while the difference in net weight (pre-session weight – post-session weight + ingested weight) was 576.07 ± 280.61 mg. Pre and post-session ambient temperatures were $22.47 \pm 2.49^\circ\text{C}$ and $23.54 \pm 2.61^\circ\text{C}$ ($p < 0.01$) respectively, humidity values were $46 \pm 8\%$ and $55 \pm 9\%$ ($p < 0.01$) respectively.

DISCUSSION

This study confirms the intense exercise intensity involved in indoor cycling. According to the American College of Sports Medicine (ACSM), this intensity of exercise can be classified as vigorous (18).

The results confirm earlier studies (10-12) suggesting the vigorous nature of indoor cycling, but in a very large sample of individuals spontaneously participating in indoor cycling, larger than in small previous experimental samples.

Our data indicate that exercise intensity remained intense over a long period: the mean time that subjects remained in the zone above 70% predicted HRmax was 37.94 min, averaging $85.95 \pm 8.72\%$ in the last part of the session. The mean HR observed here is lower than that reported in studies (6-9) in which HR was monitored while subjects pedaled on a cycle ergometer in the laboratory while watching an indoor cycling video. The high HR values recorded in these studies could be attributed to the lack of an instructor guiding the session. Another possible explanation is that in the 1990s when these studies were conducted, aggressive pedaling techniques were common. These were designed to increase training intensity and were based mainly on the use of

cadences higher than 150 rpm. Today, most indoor cycling instructor training centers do not recommend high pedaling cadences (1, 5, 19, 20).

More recently, in a conventional indoor cycling session in trained subjects, Piacentini et al. (12) recorded higher HR values than the present (163 ± 8 bpm for men, 154 ± 6.8 bpm for women), though these rates could be affected by the lack of fluid intake during the session as the subjects carried a respiratory gas monitor that required no drinks be consumed, our subjects drank *ad libitum*. This restriction leading to a drop in plasma values can increase the HR response.

Other authors have reported a lower HR than observed here for this sport's activity. Kang et al. (21) maintained training intensity within pre-established limits through feedback to the subject about the intensity at each moment in the session along with a real-time graph showing the training load distribution. This strategy helped maintain intensity within the range established by the instructor. Caria et al. (11) also observed slightly lower HR values than those recorded here. Another factor that may have affected the rates observed by Caria et al. was the use of a constant stream of air to regulate heat, which could affect HR.

In our study, 75 subjects (25%) surpassed the theoretical HR_{max} during the session. This observation supports the claims of Robergs and Landwehr (22), who argue that no acceptable method exists to estimate HR_{max}. However, the exercise industry usually use this method to calculate the relative intensity of training according to the percentage theoretical maximum heart rate (% predicted HR_{max}) or percentage reserve HR (%HRR) and thus consider it an acceptable method (18). To estimate predicted HR_{max}, the equation proposed by Tanaka (23) is probably the most appropriate, though according to the authors themselves, the equation described by Fox et al. (13) gives rise to similar results when estimating theoretical HR_{max} in 40-year-olds. Given the mean age of our subjects was 41 ± 8.05 years, both equations will generate similar results. Even though the use of predicted HR_{máx}, may introduce individuals errors in the %HR_{máx}, in a large sample such as viewed in the present study individual errors are likely to be averaged out.

We observed that subjects spent around 18% of the time below 70% predicted HR_{max} and 82% above this training zone, higher than the values observed by other authors (10, 11). This supports the idea that besides a high intensity at specific time points, in indoor cycling, an elevated intensity is maintained over a prolonged period.

The RPE scores obtained in the 10-point *OMNI-Scale* in our subjects indicate a "slightly hard" training intensity for the initial minutes of the session and "hard" in the main part of the session, corresponding to our HR quantification of intensity. Up until now, the *OMNI-Scale* had not been used to quantify training intensity in indoor cycling. Battista et al. (10) obtained similar scores to those recorded here employing the adapted 10-point Borg scale (24) related to training intensities ranging from "hard" to "very hard". Using the original Borg scale (25), López-

Miñarro and Muyor-Rodriguez (3) observed scores indicating a “hard – very hard” intensity, similar to the scores obtained in our study. Several factors not examined could have affected the behavior of RPE such as the type of training (26, 27), music (28-31) or pedaling cadence (32).

The results obtained in our investigation indicate a moderate correlation ($p < 0.01$) between RPE and HR both in absolute and relative terms during indoor cycling. Similarly, López-Miñarro and Muyor-Rodriguez (3) reported significant correlation between RPE and %HRR ($r = 0.41$; $p < 0.05$). Similar correlation was detected in studies performed on a cycle ergometer (26, 33). The correlations observed in our study between HR-RPE and % predicted HRmax-RPE were similar. The implications of this observation are important since indoor cycling is a group activity and it is more practical for the instructor to guide about the target training zone in terms of the % theoretical HRmax at which the subjects should remain at each time point.

In the present study, subjects showed a mean weight loss representing a decrease of under 0.5% body weight, indicating moderate dehydration. Fluid intake for the study sample was equivalent to around 64% of losses through sweat, according to Montain and Coyle (34), an intake representing 80% of fluids lost through sweat would be appropriate to offset the increase in body temperature.

Our findings revealed a slight increase in temperature during the cycling sessions. The mean temperature was $23.54 \pm 2.61^{\circ}\text{C}$. When ambient temperature is lower than skin temperature ($>30^{\circ}\text{C}$ during exercise), the body is able to effectively lose heat mainly through convection and radiation (35). In contrast, humidity increased by 9.17 ± 6.84 percentage units and the mean relative humidity was $54.76 \pm 8.75\%$. This humidity increase could be attributed to the small size of the studio in relation to the number of participants and to limited air renewal systems. In addition, being an indoor activity, reduced airflow on the skin will also hinder this process (35, 36). Indeed these two factors (increased humidity and reduced air flow) were probably the greatest environmental hurdles during the cycling sessions.

CONCLUSIONS

In conclusion, our findings confirm in a very large sample of spontaneous indoor cycling session the elevated cardiovascular intensity of indoor cycling. This intensity of exercise is in line with current recommendations (ACSM) for physical activity in healthy adults and may lead to beneficial cardiovascular adaptations in subjects who frequently engage in this activity. For indoor cycling sessions to be safe and effective, subjects should control their training intensity. Both the HR and RPE response are valid methods for this purpose, with significant correlation existing between the two indicators. We recommend the simultaneous use of both HR and RPE by instructors so that adequate feedback on intensity can be given to subjects during training. Both absolute HR (bpm) and relative HR (% predicted HRmax) values may be used although,

being a group activity, it might be more appropriate to control intensity through relative HR values.

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