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Influence of Gender on Heart Rate Curves during a Progressive Test in Young Runners

Guilherme Assunção Ferreira[1], Rogerio Luz Coelho[2], Gislaine Cristina de Souza[3], Poliana Lima Costa[3], Raul Osiecki[2], Fernando Roberto de Oliveira[3]

[1]Sports Science Research Group, Academic Center of Vitoria, Federal University of Pernambuco, [2]Center for the Study of Physical Performance, Federal University of Paraná, Paraná, Brazil, [3]Nucleus of Human Movement Studies, Department of Physical Education, Federal University of Lavras, Minas Gerais, Brazil

ABSTRACT

Ferreira GA, Luz Coelho R, Souza GC, Costa PL, Osiecki R, De Oliveira FR. Influence of Gender on Heart Rate Curves during a Progressive Test in Young Runners. **JEPonline** 2015;18(1):70-75. The purpose of this study was to identify the Heart Rate Deflection Point (HRDP) in young runners and, then, compare the HRDP intensities between the athletes' gender. Nineteen young runners (11 boys, age = 13.7 ± 1.6 yrs and 8 girls, age = 12.8 ± 1.3 yrs) underwent an incremental track test starting with 8 km·h^{-1} with increments of 1 km·h^{-1} every 2 min until exhaustion. The HRDP was determined using the Dmax method. Peak Velocity (PV) was lower (P<0.05) in girls than boys. Heart Rate Peak (HR peak) was similar between the two groups (P>0.05). No significant differences were found between boys and girls for velocity, HR, and %HR peak measured at HRDP. However, significantly lower values (P<0.05) in boys were found for %PV measured at HRDP. The results suggest that the relative intensities of HRDP identification in young runners appear to be associated with gender.

Key Words: Heart Rate Deflection Point, Runners, Youth, Athletes, Gender

INTRODUCTION

In endurance sports, physiological ventilatory variables and blood lactate responses are commonly used to identify the physiological transition thresholds (TT) in athletes [5,22]. Alternatively, the heart rate deflection point (HRDP) can predict in a progressive test (noninvasively and adequately) these same thresholds [6,11]. The HRDP is identified at the downward or upward loss of heart rate (HR) linearity in the final stages of a progressive exercise (i.e., ~70 to 80% of maximal power output). The HRDP has been widely used to predict the anaerobic threshold in different populations of sex, age, and fitness level [6,8,11].

Some authors suggest that the identification of the HRDP are conditioned to individual morphological and functional characteristics [8,18]. For exemple, Lucia et al. [18] observed that the HRDP was easily identified in well-trained cyclists when compared to their untrained pairs due to improved stroke volume and left ventricular ejection fraction. In another study, Hawkins et al. [14] observed that the greater stroke volume and left ventricular ejection fraction could affect the cardiovascular responses of endurance athletes during progressive exercise. Collectively, these findings support the hypothesis that morphological and functional characteristics of the heart could modulate cardiovascular behavior during exercise, thus facilitating the identification of the HRDP in endurance athletes.

Considering the differences observed in this noninvasive method to assess TT, given its widespread use and its ease of application, it seems important to evaluate their consistency and applicability in different populations. Lower stroke volume and left ventricular ejection fraction in younger athletes affect cardiovascular responses to exercise, when compared to adults [21,23]. Hence, it is plausible to suggest that the age related anatomical differences can also modify the identification of the HRDP. Additionally, there seems to be a difference in left ventricular function among trained and untrained children [20], which, in theory, could also affect the intensity of HRDP identification between these diverse populations.

Although the HRDP has been consistently studied in adults (athletes and non-athletes) [8,15,18], children [3,9] and young soccer players [12]. There are no data in the literature concerning the identification of HRDP in young endurance runners. Furthermore, it has been suggested that cardiac morphological differences between men and women may affect the identification of the HRDP in adults due to the higher systolic ventricular volume of men [8]. However, in children, gender does not seem to alter systolic ventricular function during a progressive test [19], which means that gender may not affect the HRDP in young athletes as observed in adults. Thus, the purpose of this study was to identify HRDP in young runners and, then compare these HRDP intensities between female and male athletes.

METHODS

Subjects

Nineteen young runners (11 boys, weight = 50.7 ± 10.4 kg, height = 163.4 ± 10.8 cm, age = 13.7 ± 1.6 yrs and 8 girls, weight = 49.0 ± 8.1 kg, height = 157.8 ± 7.4 cm, age = 12.8 ± 1.3 yrs) were enrolled in the study. The subjects and their parents were informed about all the methodological aspects and the risks and benefits of the study. Informed signed consent forms were obtained from all individuals and their parents. The methodological procedures were approved by the local Ethics Committee.

Procedures

Initially, the subjects were submitted to anthropometric measurements. Then the runners underwent an incremental track test starting with 8 km·h^{-1} with increments of 1 km·h^{-1} every 2 min until voluntary exhaustion [17]. The race pace was controlled by a loud beep (SpheraPortable Server software).

Measurements

The subjects' body mass was determined using a digital scale (Britânia®). Height was measured using a professional Sanny Stadiometer (Sanny ®, São Paulo, Brazil). Heart rate (HR) response was obtained using a heart rate monitor (Polar Electro Oy, FI-90440, Kempele, Finland).

Peak velocity (PV) was determined as the highest velocity maintained during a complete stage. When the last stage was not complete, the PV was considered the last stage corrected as in Kuipers [16]. The test was considered maximum when the peak HR (HR peak) reached values of ±10 beats·min^{-1} of the maximum predicted HR (HR max); whereas, HR max was predicted using the formula = 220 - age (yrs) as proposed by Cooke [7].

Heart Rate Deflection Point (HRDP)

The HRDF was individually identified as proposed by Kara et al. [15]. All HR (equal to or greater than 140 beats·min^{-1}) were plotted versus the velocity for each stage. A 3rd degree polynomial fit of all these points was calculated, then, a linear fit of the first and last points was calculated. The largest difference between these two lines was the Dmax point.

Statistical Analysis

Initially, all the data were confirmed to be normally distributed by the Shapiro-Wilk test. Then the *t*-test was employed to study the differences of Heart Rate Deflection Point (HRDP) between the boys and the girls. Significance was accepted if P<0.05. Analyses were performed with the statistical package STATISTICA 7.0 (Oklahoma, USA).

RESULTS

The PV was significantly lower (P<0.05) in the girls versus the boys (13.4 ± 0.8 vs. 15.4 ± 1.7 km·h^{-1}, respectively) and HR peak was similar between girls and boys (207 ± 1.3 vs. 205 ± 6 beats·min^{-1}, respectively). The velocity and HR measured at HRDP for both absolute (km·h^{-1} and beats·min^{-1}) and relative (%PV and %HR peak) terms are described in Table 1. No significant differences were found between boys and girls for velocity, HR, and %HR peak measured at HRDP (P>0.05), but significant differences were found for %PV identified at threshold (P<0.05).

Table 1. Absolute and Relative Velocities and Heart Rates Identified at the HRDP.

	HRDP Boys (n = 11)	**HRDP Girls** (n = 8)
Heart rate (beats·min^{-1})	186 ± 11	187 ± 9
%HR peak	90.8 ± 5.0	94.2 ± 3.1
Velocity (km·h^{-1})	11.8 ± 1.8	11.1 ± 0.9
%PV	76.4 ± 5.6*	83.2 ± 5.7

Note. HRDP = heart rate deflection point. *Denotes significant differences between boys and girls, P<0.05.

DISCUSSION

The main objective of this study was the identification of the HRDP in young athletes by the Dmax method, and to compare the identified variables at the HRDP between young female and male athletes. We chose the Leger and Boucher's [17] indirect continuous running multistage field test because it is validated for aerobic evaluation in runners. Two main results were found in the present study: (a) the identification of the HRDP was possible in all individuals of our sample; and (b) we found differences between PV% at the HRDP for boys and girls.

The mean PV was significantly lower ($P<0.05$) in girls than in boys (13.4 ± 0.8 vs. 15.4 ± 1.7 $km \cdot h^{-1}$, respectively) and HR peak was similar between girls and boys (207 ± 1.3 vs. 205 ± 6 $beats \cdot min^{-1}$, respectively). Although the values for PV and HR peak for boys are similar to those previously reported for active young people [1,9], the values found for the PV were significantly lower ($P<0.05$) in girls than in boys (13.4 ± 0.8 vs. 15.4 ± 1.7 $km \cdot h^{-1}$). The larger PV found in boys could be attributed to the difference in qualitative characteristics of the body's tissues and structures or due to a possible higher biological age in boys [4]. Although there was no significant difference in chronological age between the boys and girls, their biological age was not evaluated. Hence, the second hypothesis should be viewed as speculative only. Previous studies demonstrated that boys between 12 to 13 yrs reach higher VO_2 peak values when compared to girls of the same age [1,10]. This could partly explain the differences we found in PV between boys and girls.

We found the HRDP in our subjects, respectively for boys and girls at: (a) speed of 11.8 ± 1.8 ± and 11.1 ± 0.9 $km \cdot h^{-1}$; (b) %PV 76.4 ± 5.6 and 83.2 ± 5.7%; (c) HR 186 ± 11 and 187 ± 9 $beats \cdot min^{-1}$; and (d) %HR peak of 90.8 ± 5.0 and 94.2 ± 3.1%. Our values for the identification of HRDP intensity are lower than those found in the literature for boys, but not for girls [3,12]. However, when described as absolute values they were similar to those reported in the literature. For example, Ferreira-Júnior et al. [12] identified HRDP in young soccer players at speeds of 11.3 ± 0.8 $km \cdot h^{-1}$. However, when these values were reported in %PV, the authors identified the HRDP at 84 ± 4% of PV. In relative units, these findings suggest that for male runners our HRDP findings shifted to lower intensities. The difference found for HRDP intensities between boys and girls could be attributed to differences in running economy. Armstrong, Welsman and Kirby [1] observed that boys are less economical than girls when running. This could shift the intensity of TT to lower intensities. In addition, the differences in anaerobic capacity among male and female adolescent athletes enabled a higher power output in male athletes after TT [2,13]. This could also explain the differences in %PV we found at the HRDP between genders.

The HR in which we identified the HRDP is similar to those found in other studies with young athletes. For example, Ferreira-Júnior et al. [12] reported a HR of 185 ± 9 $beats \cdot min^{-1}$ (92 ± 2%) while Buchheit, Solano and Millet [3] reported 187 ± 9 $beats \cdot min^{-1}$ (92.1 ± 0.4%). But, these findings are different from Debray and Dey's [9] results with young non-athletes (179 ± 7 $beats \cdot min^{-1}$). Nonetheless, the use of HRDP is supported by several authors that identified the TT at similar intensities and can be regarded as a valuable aerobic capacity estimate [3,6,9,11]. Although we found some differences in some of the variables identified at the HRDP and those in the literature (i.e., %PV and HR), collectively, our findings support HRDP as a useful tool for assessment of young runners.

Limitations of this Study

As expected, this study had some limitations. For example, we did not evaluate the biological age or anaerobic thresholds of the subjects. Secondly, we did not perform gas exchanges or blood lactate measurements during exercise to determine the anaerobic and ventilatory thresholds. Thus, future studies should investigate these variables in young runners of both genders.

CONCLUSIONS

The HRDP is an easily applicable field test for in young runners regardless of gender. The differences in relative intensities of HRDP identification between boys and girls appear to be associated with difference of anaerobic capacity between genders.

Address for correspondence: Rogerio Luz Coelho, MD, Departament of Physical Education of Federal University of Parana, Rua Coração de Maria, 92 – BR 116 km 95 – Jardim Botânico – Curitiba – Paraná , CEP 80215-370, Brazil. Telephone: 55+ 9243-9703. Email: dr.rogerioluzcoelho@gmail.com

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