Sports Training

Women amateur street runners have a higher level of chronotype self-perception than men

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Abstract - Aim: The aims of the present study were to verify the self-perception level of the chronotype of amateur street runners and to test the association between the chronotype, gender, age, and preferred training time. **Methods:** A total of 166 amateur street runners were included (♀ = 89, age 38.9 ± 11.2 years; ♂ = 77, age 38.0 ± 9.7 years). The Brazilian version of the Horne & Östberg questionnaire was used to assess chronotypes and the preferred training time was determined through a multiple choice question. Based on chronotype definitions that suggest that when free to choose, morning-types (MT) would prefer training in the morning, evening-types (ET) in the evening and neither-types (NT) would not have a predilection for any specific time. The corroboration of this hypothesis was assumed as self-perception level of the chronotypes. **Results:** Women showed higher self-perception levels of their chronotype compared to men (58.4% *vs.* 41.6%; χ^2 = 4.699; p = 0.030). By chronotypes, MT, NT, and ET self-perception levels were 73.9%, 15.9%, 88.9%, respectively (χ^2 = 57.489; p < 0.001). The most observed women circadian typology was MT, while in men it was NT (χ^2 = 8.951; p = 0.011). However, there was no significant association between gender and preferred training time (χ^2 = 2.654; p = 0.265). Age, female gender and preference to exercise during the day are associated with MT. **Conclusion:** Women runners showed a greater perception of their circadian traits than men, despite there was no association between gender and preferred training time.

Keywords: age, chronobiology phenomena, circadian rhythm, gender, running.

Introduction

Street races officially held in the Brazilian national territory are regulated by the Brazilian Athletics Confederation (CBAt), an entity affiliated with World Athletics, and following international rules[1]. Running involves men and women of various ages and physical fitness levels. In addition, the races take place at different times of the day, configuring a special point of interest for optimizing physical performance. These multiple factors provide a challenge for runners and coaches, especially from the perspective of the temporal organization of sports performance. In this sense, knowledge about inter-individual preferences for morning or evening hours which occurs as a reflection of circadian rhythmicity and external synchronizers, meaning the chronotype[2], has become relevant for both the scientific and practitioners' context of sports training.

Chronotype is usually evaluated using self-assessment questionnaires such as the Morningness−Eveningness Personality Questionnaire (HÖ-MEQ)[3], the Composite Scale of Morningness (CSM)[4], and the Munich Chronotype Questionnaire (MCTQ)[5]. The chronotype can alternatively be determined from sleep parameters[6]. In the sports context, assessment of the circadian phenotype has covered runners of different levels[7,8], professional rugby players[9], cyclists[10], swimmers[11], collegiate rowers[12] and hockey and soccer players[13,14].

The presence of endogenous rhythms would constitute an evolutionary acquisition reflecting a long consolidation process of an intrinsic timing system adapted to cyclical variations in fundamental elements of the environment, such as the presence/absence of light[15]. According to Minati et al.[16] circadian types demonstrate the prevalence of sleep/wake time, and individuals classified

as morning-types (MT) generally show greater activity and mood during the first hours of the clear phase, and those classified as evening-types (ET) show greater activity and mood during the first hours of the dark phase. Individuals classified as neither or intermediate-types (NT) tend to be more flexible, adjusting better to the schedules imposed by daily routines. Interestingly, although scoring the same result in the NT category, evidence suggests the existence of a circadian typology known as bimodal-types, which can be characterized by having two bouts of activity patterns with respect to the time of day[17].

In addition, gender and age are factors which can alter the perception in self-knowledge of an individual's chronotype. Fischer et al.[18] evaluated the chronotype distribution of 53,689 Americans over 12 years and observed that more than 50% of the chronotype changes throughout life occur during adolescence and early adulthood, and that this variation decreases with age. In a study with 14,650 volunteers on ontogenic modulation of the gender-related chronotype, Duarte et al.[19] reported that men apparently have greater plasticity in their circadian timing system throughout their lives. However, the same authors claim that the results of the literature regarding the interaction between gender, age and chronotype are few and contradictory at the time of the study.

Considering the hypothesis that age and gender might impact chronotype characterization with effects in sports performance, the aims of the present study were to verify the self-perception level of the chronotype of amateur street runners and to test the association between the chronotype, gender, age and preferred training time.

Methods

Participants

A total of 166 amateur street runners ($\female$ = 89, age 38.9 $\pm$ 11.2 years; $\male$ = 77, age 38.0 $\pm$ 9.7 years) mostly from the area of Belo Horizonte, MG, Brazil, volunteered to participate in this study. All volunteers included had participated in at least one street race over five kilometers in the previous 12 months and gave written informed consent in accordance with the Declaration of Helsinki. This protocol was approved by the Local Research Ethics Committee (number 4.033.818) and followed the rules established by the National Health Council in research involving humans.

Experimental procedures

This is a descriptive observational cross-sectional study carried out with amateur street runners between the months of July and August 2018. The running teams were cataloged and contacted via social media (Facebook, Whatsapp, and Email) to present the research objectives and procedures. After authorization from the coordinators,

the Informed Consent Form containing the main information regarding the nature of the research was sent to the runners via Google Forms (Google©). If they digitally agreed, the volunteers were then directed to questions regarding the chronotype assessment and preferred training time using this same online tool. The questionnaires were anonymous, to maintain the privacy and confidentiality of all the information reported in the present research.

The chronotype was identified through the HÖ-MEQ[3] validated for the Brazilian population[20]. The HÖ-MEQ consists of 19 objective multiple choice questions. Each answer receives a value and the summation results in a final score ranging from 16 to 86. The final score enables identifying the extreme morning-types (70-86), moderate morning-types (59-69), neither-types (42-58), moderate evening-types (31-41) and extreme evening-types (16-30) chronotypes.

The preferred training time was determined through a multiple choice question with the following answer options: morning, evening and no specific time. Based on chronotype definitions that suggest that when free to choose, MT would prefer training in the morning, ET in the evening and NT would not have a predilection for any specific time[21,22]. Thus, the corroboration of this hypothesis was assumed as self-perception level of the chronotype.

Statistical analysis

Normality was tested using the Shapiro-Wilk test. Non-parametric data were analyzed by the Kruskal-Wallis ANOVA by ranks. The Pearson's chi-squared test (χ^2) was used to compare the frequency distribution of the chronotypes according to gender, and the preferred training time with gender. Logistic regression was used to assess the relationship between the chronotypes (dependent variable) and gender, age and preferred training time (independent variables). All statistical procedures were performed using SPSS 20.0 software package and the level of significance was set at $p < 0.05$.

Results

Figure 1 shows the frequency distribution by the score obtained on the HÖ-MEQ following as presented by Cruz et al.[8] The HÖ-MEQ score range in this study from 32 to 74.

The circadian phenotypes were classified into three categories based on the HÖ-MEQ score. This classification model was adopted to meet the recommendation of grouping categories from the chi-squared test (χ^2) in case there is any answer less than 1. Table 1 presents the proportion distribution results of the chronotype by gender. The most observed women circadian typology was MT, while in men it was NT (χ^2 = 8.951; p = 0.011). However,
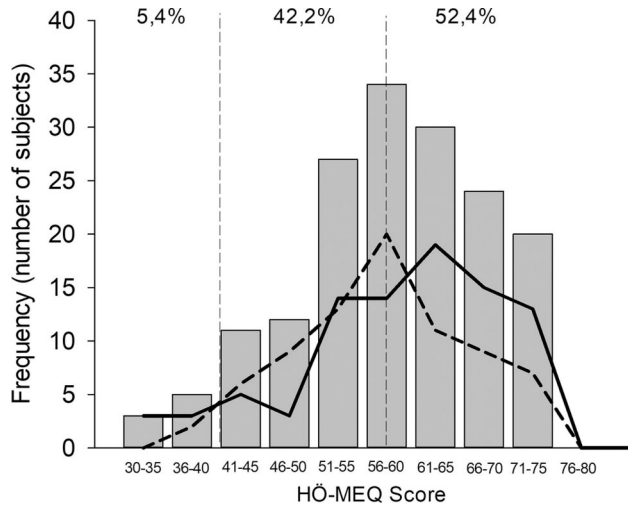
Figure 1 - Frequency distribution of the score obtained on the HÖ-MEQ. The dashed line indicates men, and the solid line indicates women. Classification: evening-types (≤41), neither-types (42-58), morning-types (≥59).

Table 1 - Absolute and relative distribution (%) of the chronotypes by gender.

Gender	MT	NT	ET	Total	χ^2	p
♂	34 (44.2%)	41 (53.2%)	2 (2.6%)	77 (100%)	-	-
♀	54 (60.7%)	28 (31.4%)	7 (7.9%)	89 (100%)	-	-
Total	88	69	9	166	8.951	0.011

Legend: ♂ = men; ♀ = women. MT (morning-types), NT (neither-types), ET (evening-types).

there was no significant association between gender and preferred training time ($\chi^2 = 2.654$; $p = 0.265$) (Table 2).

Women showed higher self-perception levels of their chronotype compared to men (58.4% *vs*. 41.6%; $\chi^2 = 4.699$; $p = 0.030$; Figure 2A). By chronotypes, MT,

Table 2 - Absolute and relative distribution (%) of preferred training hours by gender.

| Gender	Morning	Evening	No specific time	Total	χ^2	p
♂	49 (63.6%)	17 (22.1%)	11 (14.3%)	77 (100%)	-	-
♀	55 (61.8%)	27 (30.3%)	7 (7.9%)	89 (100%)	-	-
Total	104	44	18	166	2.654	0.265

Legend: ♂ = men; ♀ = women.

NT, and ET self-perception levels were 73.9%, 15.9%, 88.9%, respectively ($\chi^2 = 57.489$; $p = 0.000$; Figure 2B). According to the standardized adjusted residual, MT and ET presented higher self-perception levels than expected. However, the NT showed the opposite pattern.

HÖ-MEQ data by gender and age range were arbitrarily allocated to four subgroups, being: ≤ 29, 30-40, 41-51 and ≥ 52 years (Table 3). Younger men (≤ 29 years) had lower HÖ-MEQ score than older men (≥ 52 years). However, there were no differences between genders regardless of age, or overall averages for men and women (♂ = 57.7 ± 8.8; ♀ = 59.5 ± 10.3; $p = 0.094$).

Despite the chronotype categorization into three categories, the data referring to the evening data were excluded from logistic regression due to the low number of individuals in this group. Age, female gender and preference for exercise during the day are associated with the morning chronotype (Table 4). The probability of belonging to the morning group increases by 4% for each year of life compared to the neither group ($p = 0.023$; Odds ratio = 1.041; $CI_{95\%} = 1.005$-1.078).

Moreover, specifically being female increases the probability of belonging to the morning group by 174% compared to the male gender ($p = 0.005$; Odds ratio =
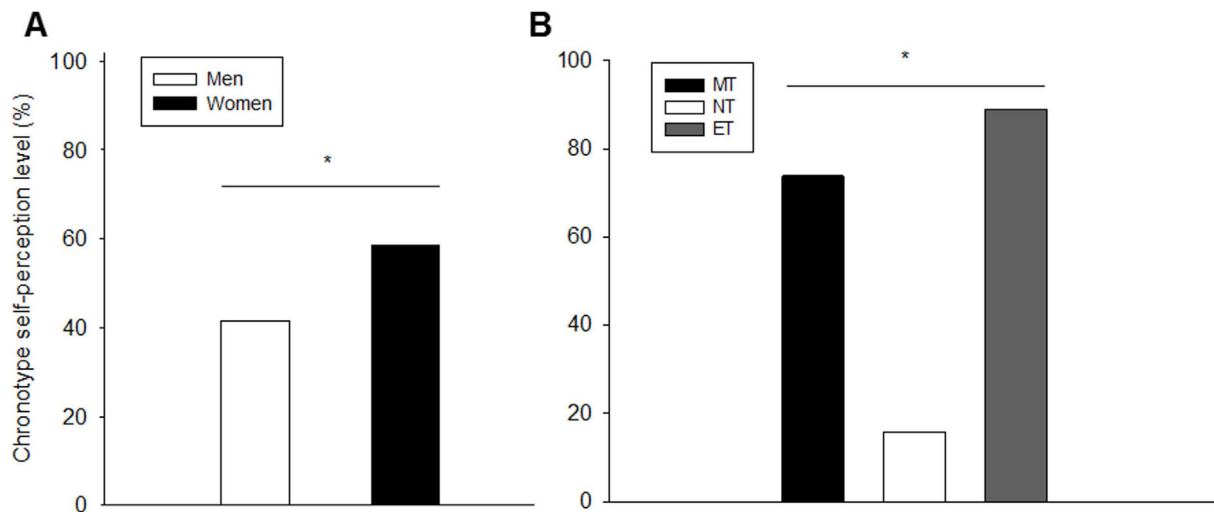
Figure 2. - Chronotype self-perception level (%) by gender (A) and chronotypes (B). MT (morning-types), NT (neither-types), ET (evening-types). *denote difference from MT and NT to expected values ($p < 0.05$).

Table 3 - Stratification of HÖ-MEQ scores by gender and age range.

Age range	Gender	HÖ-MEQ	n	p
≤ 29 years	♂	54.4 ± 9.3	12	0.050*
	♀	55.1 ± 8.9	16	n.s
30-40 years	♂	56.1 ± 7.9	34	n.s
	♀	59.7 ± 10.4	43	n.s
41-51 years	♂	59.3 ± 9.0	19	n.s
	♀	61.7 ± 10.7	22	n.s
≥ 52 years	♂	63.1 ± 8.7	12	n.s
	♀	61.4 ± 9.6	8	n.s

Legend: Data presented as mean ± standard deviation.
*denote difference from men ≤ 29 *vs.* ≥ 52 years; n.s = not significant

2.742; $CI_{95\%}$ = 1.347-5.581). In addition, preferring to perform physical exercises during the day increases the probability of belonging to the morning group by 213% compared to the group at no specific time (p = 0.037; Odds ratio = 3.133; $CI_{95\%}$ = 1.070-9.173), and increases the probability by 464% compared to the evening group (p < 0.001; Odds ratio = 5.640; $CI_{95\%}$ = 2.363-13.458).

Discussion

The aims of the present study were to verify the self-perception level of the chronotype of amateur street runners and to test the association between the chronotype and the gender, age and preferred training time. The main finding was that the self-perception level of the chronotype was higher in women compared to men. Nonetheless, the difference in the chronotype distribution frequency between the two genders demonstrated a gender effect. In practice, these results could be a key point for consideration by trainers and physical educators when scheduling training sessions or choosing a competition, mainly based on a possible effect of chronotype on athletic performance.

It is necessary to highlight that the hypothesis that there would be a relationship between gender and chronotype has been investigated with representative samples,

especially with an interaction of the age factor. In our study, younger men had lower HÖ-MEQ scores than their older peers (≤ 29 *vs.* ≥ 52 years), indicating an ontogenic dynamic of chronotype variation. The presence of this phenomenon was reported by Fischer et al.[18] indicating that the eveningness peak in men and women occurs around 19 and 20 years old, respectively, and that men tend to be more MT than women after 40 years old. Accordingly, Duarte et al.[19] also showed a phase delay in adolescents and a phase advance in Brazilians older adults, and this seems to be a phenomenon which is markedly more present in men. It is speculated that the most likely reason for this variability in chronotype of men and women appears to be related to hormonal factors[18,19]. Testosterone is known to play an important role in chronotype changes during puberty in mammals[23]. In humans, some evidence suggests the presence of sex hormone receptors in the suprachiasmatic nucleus of the hypothalamus[24]. Moreover, it is important to mention about the changes that occur in sleep phase preferences during puberty, especially in the 5 years post-menarche. At older ages, we can summarize that decreased testosterone and estrogen during menopause (female) and andropause (male) could explain a trend towards morningness in this age range[19]. Chronically, it is believed that the increased incidence of morningness habits with advancing age may cause changes in the chronobiological phenotype, in particular due to changes in the sensitivity of the endogenous timing system to the light-dark cycle, regardless of gender[25].

In other study involving hormonal circadian regulation, Gunn et al.[26] observed that females exhibited significantly greater levels of plasma melatonin and cortisol than males. Females also exhibited a significantly higher amplitude rhythm in both hormones. However, the authors reported that was not possible to distinguish whether the elevated plasma melatonin and cortisol levels observed in females resulted from innate sex differences or the oral contraceptive pill affecting the synthetic and metabolic pathways of these hormones. Conversely, non-hormonal causes can act as modulators of the circadian timing sys-

Table 4 - Model Coefficients − Chronotypes.

Predictor	Estimate	SE	Z	p	Odds ratio	95% Confidence Interval	
						Lower	Upper
Intercept	−1.2686	0.731	−1.73	0.083	0.281	0.067	1.179
Age	0.040	0.017	2.27	0.023	1.041	1.005	1.078
Gender:							
female - male	1.008	0.362	2.78	0.005	2.742	1.347	5.581
Schedule:							
Day - Night	1.729	0.443	3.90	< 0.001	5.640	2.363	13.458
Day - Any time	1.142	0.548	2.08	0.037	3.133	1.070	9.173

Legend: Estimates represent the log odds of MT *vs.* NT. Collinearity Statistics (Tolerance): Age = 0.988; Gender = 0.982; Schedule = 0.991. %Correct: NT = 56.5%; MT = 78.4. Accuracy = 0.688.

tem, as well as behavioral and social factors (i.e. family lifestyle and work regimes), in addition to somatic and mental disordes[18,19].

There was a general predominance of MT among runners (n = 88; 53%), which can be partially explained by the predominance of this phenotype among women. According to Henst et al.[7] the predominance of morningness in South African marathon runners compared to Dutch athletes seems to be related to climatic issues, since the prevailing climate in Africa predisposes individuals to perform training in the morning, in addition to the fact that the competitions almost always occur in the morning. Thus, the summing effects of the climate, training schedule and higher training volume throughout the week for South Africans predispose individuals to the morning profile. In fact, the typical climatic conditions of tropical countries like Brazil and South Africa can partially explain these results. However, our sample group consisted of amateur runners, with little control over physical training parameters and who train and/or compete at different times of the day.

When asked about the preferred training time, runners classified as MT and ET reported preferring to train in the morning (73.9%) and evening (88.9%), respectively. Conversely, only 15.9% of NT individuals corroborated the theoretical hypothesis assumed for this category of not having any specific preferred time, thus reflecting the absence of an individual pattern for this group. Our results also demonstrated that the preference for physical exercise in the morning increases the probability of belonging to the morning group by 213% compared to the no specific time group, and increases the probability by 464% when compared to the evening group. It should be noted that the preference may not reflect the actual training and competitions schedule[11], although individually these athletes have better flexibility regarding their training schedule compared to collective characteristic modalities[9]. Cruz et al.[8] pointed out that the overload of daily, work and family activities means that many amateur morning runners are unable to reconcile their training schedules with their individual preferences. In fact, these studies demonstrate the importance of adapting the practice schedule according to the chronotype, especially according to the chronotype obtained through the HÖ-MEQ. Kunorozva et al.[10] observed that the subjective perception of effort by cyclists who were proven to be submitted to tests with varying intensities at different times is higher during the evening (18 and 22 h) when compared to other periods (6, 10, 14 h), indicating greater capacity to resist fatigue in the early hours of the day.

Another important point for discussion concerns the way of interpreting and classifying the data obtained in the HÖ-MEQ. According to the original reference proposed by Horne & Östberg[3], the chronotype is classified into five subtypes, being MT and ET divided into moderates and extremes, in addition to neither-types. In this perspective, the NT would be prevalent in the present study (n = 69) and no longer the MT as effectively observed, as we would have 24 extreme morning-types and 64 moderate morning-types. In fact, this is not an error, but an important aspect to consider for analyzing and interpreting the results. In this scenario, athletes would behave similarly to the majority of the non-athlete adult population[21]. However, several studies have adopted the classification model grouped into only three categories, without subdividing morning-types and evening-types[2,8,10-12,27]. Although not justified, it is assumed that this model was chosen because the extreme individuals are not so present and/or to facilitate statistical analysis of the data.

Conclusion

Women runners showed a greater perception of their circadian traits than men, despite there was no association between gender and preferred training time. Further studies should be designed to assess the chronotype relationship with gender and age over time in different sports, and if possible, including hormonal analysis and performance parameters.

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