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Impact of training volume and experience on amateur Ironman triathlon performance

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ABSTRACT

Purpose: To investigate the association between training volume, sleep time, signs and symptoms of excessive training (overtraining), and previous triathlon experience with overall and split race times in the Ironman distance triathlon.

Methods: Ninety-nine triathletes (19 women and 80 men) answered an online survey containing questions about anthropometric characteristics (body mass and height), weekly training volume (hours per day and days per week), previous experience in Ironman distance triathlon race, and signs and symptoms of excessive training. Data of race times of all participants were collected by a single race (the Ironman Brazil 2019 – Florianópolis). All surveys were collected between 28 and 30 days before the race. The athlete was instructed to answer the questions according to what was happening in the week before completing the survey.

Results: **:** Total race time did not differ among those who trained up to 14 h per week (11:28:46±01:54:30 h:min:*sec*), between 15 and 20 h per week (11:37:31±01:20:26 h:min:*sec*) or more than 20 h per week (11:30:18±01:31:28 h:min:*sec*) ($p = 0.922$). Total race time of the triathletes who presented (12:42:22±01:49:36 h:min:*sec*) or no (11:23:06±01:29:02 h:min:*sec*) unintentional body mass loss ($p = 0.006$), feeling (12:46:17±02:03:13 h:min:*sec*) or no (11:24:09±01:28:07 h:min:*sec*) of decreased performance ($p = 0.009$) or feeling (12:08:58±01:47:12 h:min:*sec*) or no (11:16:34±01:24:53 h:min:*sec*) loss of energy ($p = 0.011$) in the week prior to the race were significantly different. Triathletes who had a previous experience in Ironman races achieved a better performance (11:15:21±01:32:04 h:min:*sec*) than those without previous experience (12:06:38±01:32:10 h:min:*sec*) ($p = 0.010$).

Conclusion: In summary, high volumes of training (more than 20 h per week), when performed forty days before a race, may not have a positive impact on performance compared to lower volumes of training (up to 14 h per week). However, athletes who had a previous experience in Ironman race presented better results in swimming splits and overall race time. Moreover, the presence of overtraining symptoms, such as unintentional loss of weight, sensation of fatigue and/or performance decrease impact negatively triathlon performance.

1. Introduction

Triathlon is an endurance sport discipline composed of three sequential activities performed with no intervals: swimming, cycling, and running over multiple distances and formats [1]. The number of participants in this sport has increased significantly over the last decades

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(there are more than four million triathletes globally) [2,3], spurring a growing interest for the main determinants of performance [4–7]. There is relative consensus in the literature data that the main physiological determinants of performance in this kind of predominantly aerobic sporting event are: maximum oxygen uptake ($\dot{V}O_{2max}$), anaerobic threshold (AT), and running economy [7,8]. In addition, morphological aspects such as a low body fat percentage or high fat-free mass also seem to be associated with a better performance [6,9–11].

To improve the physiological and morphological factors that determine performance in endurance races, athletes will often increase their training volume, especially training duration, among other training strategies, such as intensity [6]. Elite triathletes tend to train more than 20 h/week [12], whereas amateur triathletes train about 13 h/week [13]. This training load of amateur triathletes is half the time of professional triathletes, but more than the training volume of amateur marathon runners of 5 h/week [13]. Despite high weekly training volume is performed and linked to the best results obtained by elite athletes in endurance triathlon races [2,6,14,15], amateur athletes might respond differently. The importance of a given variable for performance can be influenced by the athlete's competitive level, as it has already been shown for running economy [7].

Amateur athletes usually have less time to dedicate to a training regimen, because their professional activity, is not associated with triathlon races. Thus, to improve performance without reducing working and leisure hours, amateur athletes often reduce training routine recover due to the reductions in time spent sleeping. Most adults require 7 to 9 h of sleep per night, and athletes may need additional time to properly recover due to the physical stress imposed by training routine recover due to the physical stress imposed by training routine [16]. Reducing the recommended minimum hours of sleep and recovery could generate a sense of fatigue and psychological stress and negatively impact sport performance (speed and anaerobic power), cognitive functions (concentration, attention, and memory), and physical (injury risk) and mental (mood disorders) health [6,16–19]. Considering these specificities and routine differences of amateur triathletes in relation to elite athletes, and the lack of literature data on amateur athletes, it is important to understand how these factors affect the performance of amateur athletes.

In addition, athletes who presented an imbalance between excessive training stimulus and adequate rest periods may develop overtraining syndrome, which is a condition of maladapted physiology in the setting of this imbalance [20]. The exact etiology and pathogenesis of this syndrome are unknown. Despite several different biomarkers have been suggested to diagnose the overtraining syndrome [21,22], there is no definitive marker able to diagnose it properly [20]. Therefore, the diagnosis of an overtraining syndrome is complex and based on clinical features. Although it is not possible to diagnose overtraining only through the presence of some signs and symptoms, there are some complaints that are common in the presence of the overtraining syndrome [23]. For example, decrease in performance is one of the most common sign of overtraining, and usually it is also accompanied by physiological, immunological, biochemical and psychological alterations [20,24]. Fatigue feeling and unintentional weight loss are also very common in overtraining syndrome [24]. Therefore, it is possible that a high volume of training for amateur triathletes does not generate the desired performance and health benefits if they are not able to compensate with adequate periods of rest and recovery.

In order to improve the understanding of the impact of training volume and experience on triathlon performance, the main aim of the present study was to compare the triathlon performance among individuals who present different weekly training hours, sleep different hours per night, and present some symptoms of excessive training (e.g., fatigue feeling, unintentional weight loss and performance decrease). A secondary aim was to compare sex differences according to the triathlon performance, training characteristics, and signs and symptoms of excessive training. The hypothesis of this study is that the quantity of hours of weekly training is not associated with the performance of amateur triathletes but that indicators of excessive training (few hours of sleep, perception of fatigue or performance decrease, and unintentional weight loss) are associated with lower performance.

2. Methods

2.1. Ethical approval

All experimental procedures were approved by the Human Research Ethics Committee of Federal University of Sao Paulo (approval number 3318,080) and conformed to the principles outlined in the Declaration of Helsinki. All participants voluntarily gave their informed consent to participate in the study after having read the purpose of the study in the first section of the electronic survey.

2.2. Participants

The invitation to participate in the survey was made through an online survey distributed via email to the "Ironman Brasil company's" (http://ironmanbrasil.com.br) mailing list to 8840 athletes. The survey was structured and applied using Google Forms digital platform and distributed 30 days before the Ironman Brazil race (held in Florianópolis, Brazil, in May 2019). All surveys were collected between 28 and 30 days before the race. The athlete was instructed to answer the questions according to what was happening in the week before completing the survey. Therefore, the answers were related to the conditions of the athletes in the fifth week before the race. There were 1286 atletes competing on Ironman Brazil race 2019. (1109 man and 177 women). Initially, 942 responses were received. Of the 942 responses received, 14 were excluded for being duplicates and/or incomplete, and 829 were excluded because the respondent did not apply for the race (the survey was distributed to the company's mailing list, not the participant list). As such, entries of 99 respondents (80 men and 19 women) were eligible to participate in this study (**Fig. 1**). The sample data described is shown in **Table 1**.

2.3. Data collection

The questionnaire was applied in Portuguese language and the responders are instructed to answer according the last week conditions. The questionnaire was composed of 3 sections. The first section included questions about: sex (male or female), age (open-ended question), body mass (open-ended question), height (open-ended question) and email address (open-ended question). Section two included questions about: swimming training hours per week in the last week (up to 2 h per week, between 3 and 4 h per week, more than 5 h per week), cycling training hours per week in the last week (up to 6 h per week, between 7 and 8 h

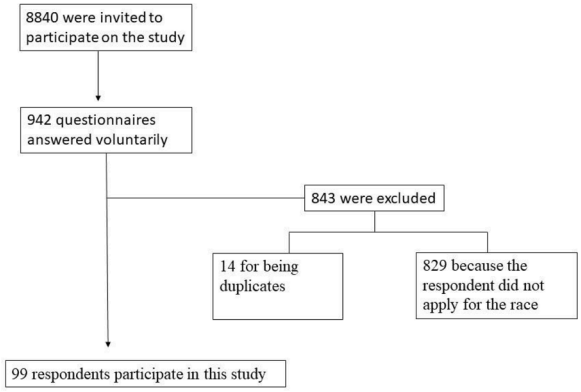

Fig. 1. Trial flowchart.

Table 1
. Anthropometric characteristics and triathlon race performance of participants.

Variables	Male $N = 80$	Female $N = 19$	p value	Power value	Effect size (d value)
Age (years)	39.0 ± 5.7	36.5 ± 6.5	0.107	0.48	0.41
Body mass (kg)	74.2 ± 7.8	59.5 ± 5.5	<0.01*	1.00	2.18
Height (cm)	176.9 ± 6.2	166.6 ± 6.6	<0.01*	0.99	1.60
BMI (kg/m^2)	23.9 ± 2.2	21.5 ± 1.9	<0.01*	0.99	1.17
Overall race time (h:min:*sec*)	11:17:17±01:24:27	12:36:14±01:46:25	<0.01*	0.94	0.82
Swimming split time (h:min:*sec*)	01:07:56±00:12:18	01:18:36±00:10:43	<0.01*	0.97	0.92
Cycling split time (h:min:*sec*)	05:36:36±01:04:07	06:06:35±01:38:06	0.190	0.40	0.36
Running split time (h:min:*sec*)	04:04:49±01:00:12	04:23:37±01:20:14	0.262	0.27	0.26

BMI: body mass index.

per week, more than 9 h per week), running training hours per week in the last week (up to 4 h per week, between 5 and 6 h per week, more than 7 h per week), total weekly training hours in the last week (up to 14 h per week, between 15 and 20 h per week, more than 20 h per week) and previous triathlon Ironman race experience (No or Yes). Third section include questions about: sleep time per night in the last week (less than 3 h, 4 to 6 h, 7 to 8 h or more than 9 h per night), feelling of fatigue in the last week (Yes or No), perception of decreased performance in the last week (Yes or No), unintentional body mass loss in the last week (Yes or No). It is noteworthy that a validated questionnaire was not used, because there is no previous validated questionnaire with a focus on the variables that were investigated in the present study (i.e. triathlon training characteristics, perception of decreased performance and etc.). To diminish this bias, we tested questionnaire reprodutibility through intraclass correlation coefficient (ICC). To this end, athletes answered the survey twice with one day interval. This analysis showed that ICC between the two surveys was classified as excellent for all the survey questions. For the question about unintentional recently loss of body mass, ICC was 1.0 (IC 95% 1.0–1.0). For the question about feeling of decreased performance ICC was 0.78 (IC 95% 0.56 – 0.89). For the question about loss of energy the ICC was 0.76 (IC95% 0.52 – 0.88). For the question about sleep time ICC was 0.83 (IC 95% 0.66–0.91). Finally, ICC values for the questions about the swimming weekly training hours was 0.75 (0.50–0.86), cycling weekly training hours was 0.89 (IC95% 0.78–0.95) and running weekly training hours was 0.78 (IC95% 0.55–0.89). For the aim of the study the second survey was used.

For the purpose of analysis, respondent athletes were grouped according to the number of weekly training hours in each discipline. Swimming: group 1 (up to 2 h per week, $n = 25$), group 2 (between 3 and 4 h per week, $n = 49$), group 3 (more than 5 h per week, $n = 25$). Cycling: group 1 (up to 6 h per week, $n = 17$), group 2 (between 7 and 8 h per week, $n = 39$), and group 3 (more than 9 h per week, $n = 43$). Running: group 1 (up to 4 h per week, $n = 42$), group 2 (between 5 and 6 h per week, $n = 45$), group 3 (more than 7 h per week, $n = 12$). Summation of all training sessions: group 1 (up to 14 h per week, $n = 31$), group 2 (between 15 and 20 h per week, $n = 36$), group 3 (more than 20 h per week, $n = 32$).

Eligibility criteria adopted included being at least 18 years of age, literate, familiar with online questionnaires, and having enrolled in and completed the 2019 Ironman Brazil race (3.8 km swimming, 180 km cycling, 42,195 km running).

2.4. Statistical analysis

The data have been expressed as mean ± standard deviations (SD). The variable distribution was tested with the Kolmogorov–Smirnov method and the variance with the Levene method. Descriptive data has been presented as absolute numbers and/or percentages.

A intraclass correlation coefficient (ICC) was calculated to test the reprodutibility of the questionnaire. ICC values less than 0.40 was classified as poor, between 0.40 and 0.59 as fair, between 0.60 and 0.74 as good, and between 0.75 and 1.00 was classified as excellent [25].

An unpaired *t*-test was used for sex comparisons related to anthropometric data and performance in the race. The measurements of the effect size were calculated by dividing the mean difference by the pooled standard deviation. The magnitude of the effect sizes was judged according to the following criteria: $d = 0.2$ considered a 'small' effect size; *0.5* represented a 'medium' effect size; and *0.8* a 'large' effect size [26].

For comparison between sexes and: sleep time per night, loss of energy in the previous week, recent unintentional weight loss, performance decrease in the previous week, previous experience in Ironman race, and weekly training hours, a chi-square test was employed. The Cramer's V was used as a measure of effect size for chi-square tests [27]. Data were grouped so that all expected frequencies were higher than five.

The *t*-test (two means) and the one-way ANOVA (more than two means) tests were applied to compare the performance between the measured interdependent variables. The one-way ANOVA test was complemented by *post hoc* tests (Tukey test) when necessary. Statistical analysis was performed using the Statistical Package for Social Sciences program (SPSS v 21.0., Chicago, Illinois, USA). In all comparisons, p values < 5% were accepted asstatistically significant.

3. Results

When the triathlon performance (total race time) was compared among athletes with different weekly hours (group 1 composed of those who trained fewer hours and group 3 of those who trained more hours), no significant difference was observed ($p = 0.922$). The swimming ($p = 0.643$), cycling ($p = 0.612$), and running ($p = 0.734$) split times also were not significantly different between groups with different weekly training hours in each discipline (**Table 2**).

On the other hand, athletes who reported unintentional body mass loss in the month before the race presented higher overall race time ($p = 0.006$). The athletes who reported a perception of lack of energy presented a significantly higher time in all split times (swimming $p = 0.022$, cycling $p = 0.018$, running $p = 0.017$) and overall race time ($p = 0.011$). Concerning sleep time, there was no performance difference between those who sleep from 4 to 6 h and those who sleep from 7 to 8 h per night (**Table 3**). Similarly, those who reported a performance decrease also had significantly higher overall race time ($p = 0.009$). Previous experience in Ironman distance triathlon races also proved to be an important variable for performance, as those who had previously participated in an Ironman race had better swimming times ($p = 0.030$) and overall race time ($p = 0.010$).

There were no significant differences between sexes according to the sleep time per night, loss of energy, unintentional loss of weight, performance decrease, and training hours (total, swimming, cycling, or running). Only the previous experience in an Ironman race differed between sexes ($p = 0.01$) (a higher percentage of males presented previous experience in triathlon Ironman distance race than the female athletes) (**Table 4**).

Table 2
Overall race time and split times of swimming, cycling and running of each weekly training hours group.

	Group 1	Group 2	Group 3	
Swimming split time (h:min:*sec*)	01:11:24±00:10:15	01:08:45±00:14:33	01:10:57±00:11:34	F(2,96)=0.443, $p = 0.643$
Cycling split time (h:min:*sec*)	05:34:09±01:36:20	05:36:45±01:29:17	05:50:40±00:40:27	F(2,96)=0.493, $p = 0.612$
Running split time (h:min:*sec*)	04:10:17±00:46:24	04:03:42±01:23:06	04:19:44±00:45:29	F(2, 96)=0.310, $p = 0.734$
Overall race time (h:min:*sec*)	11:28:46±01:54:30	11:37:31±01:20:26	11:30:18±01:31:28	(F(2, 96)=0.081;$p = 0.922$

Table 3
Triathlon performance between those who presented or not unintentional loss of weight, performance decrease, loss of energy, different sleeping hours per night and those who have or not previous experience in Ironman race.

		Swimming time (h:min:*sec*)	Cycling time (h:min:*sec*)	Running time (h:min:*sec*)	Overall race time (h:min:*sec*)
Unintentional recently loss of weight	Yes	01:08:24±00:22:51	05:52:54±02:01:17	04:33:24±01:44:31	12:42:22±01:49:36
	No	01:10:12±00:10:55	05:40:54±01:04:54	04:04:59±00:57:58	11:23:06±01:29:02
p values		0.650	0.597	0.159	0.006*
Feeling of decreased performance	Yes	01:12:46±00:27:42	05:52:02±02:14:17	04:22:39±01:44:05	12:46:17±02:03:13
	No	01:09:40±00:10:08	05:41:16±01:04:09	04:06:50±01:00:06	11:24:09±01:28:07
p values		0.471	0.661	0.470	0.009*
Loss of energy	Yes	01:14:26±00:11:51	06:08:34±00:43:41	04:32:07±00:56:19	12:08:58±01:47:12
	No	01:08:02±00:12:47	05:30:57±01:20:30	03:58:08±01:06:35	11:16:34±01:24:53
p values		0.022*	0.018*	0.017*	0.011*
Sleep time per night	Yes	01:10:31±00:14:36	05:37:09±01:33:58	04:09:18±01:19:34	11:46:07±01:38:15
	No	01:09:22±00:10:34	05:48:06±00:39:38	04:07:28±00:45:22	11:17:18±01:29:25
p values		0.658	0.461	0.890	0.132
Previous triathlon experience in Iron man race	Yes	01:08:01±00:13:08	05:35:02±01:10:48	04:01:36±01:04:55	11:15:21±01:32:04
	No	01:13:55±00:11:15	05:56:59±01:16:52	04:22:06±01:04:48	12:06:38±01:32:10
p values		0.030*	0.161	0.142	0.010*

4. Discussion

The main findings of the present study were (i) the performance between amateur triathletes who compete in Ironman distance were not different between those who train up to 14 h per week, between 15 and 20 h per week or more than 20 h per week forty days before a race (ii) there was no difference in performance between the groups that slept between 4 and 6 h and the group that slept between 7 and 8 h, (iii) triathletes who had a previous experience in an Ironman race presented a better performance than those who had never participated, (iv) triathletes who reported an unintentional loss of body mass, feeling of performance decrease or loss of energy, forty days before a race, presented bad results the Ironman race, and (v) there were no difference between sexes in triathlon weekly training hours, unintentional loss of weight, feeling of performance decrease or loss of energy.

The sample of the present study was composed of 80 male and 19 female athletes. It is interesting to note the disproportion of male and female athletes is also reflected in the participants of the triathlon races. This is despite the number of female athletes increasing in recent years [28]. At Hawaii's Ironman World Championship, female participation increased from 20 in 1981 (6% of participants) to over 470 in 2010 (27% of participants). However, the majority of participants are still male [14].

The first important finding was that there was no significant difference observed between the performance of those triathletes who train between 9 and 20 h a week forty days before a race. The results of this study indicate that the volume of training of amateur athletes is high and is similar to the volume performed by professional athletes. It was observed that 33% of men and 32% of women trained more than 20 h per week, which is similar to the elite weekly training hours [12]. The performance in each sub-discipline of the triathlon (swimming, cycling or running) was also not significantly different among those who spent different quantities of hours in the weekly training of the respective discipline. Possibly, the extremely high volumes of training are negatively impacting recovery time, which may lead to increased perception of fatigue and decreased interest or motivation in performance. Therefore, the high training volumes that have been recommended for elite athletes to improve aspects traditionally known as determinants of performance, such as $\dot{V}O_{2max,}$ AT or running economy [8] may not be as beneficial for amateur athletes considering time restrictions or competing life responsibilities. Future and longitudinal studies should be done to evaluate this hypothesis. Moreover, the athletes were asked about their weekly training hours forty days before the race, and we have no data about the training volume during the entire preparation for the race.

According to the sleep time per night, the results showed no difference in performance between the groups that slept between 4 and 6 h and the group that slept between 7 and 8 h. However, it is important to point out that in this study, individuals who slept for 4, 5 or 6 h were included in the same group, which could introduce a potential bias since there is a large variation in the sleep time in this group. In addition, evaluating only the number of sleep time alone may not be the best parameter, since it is well established in the literature that there are different sleep profiles of individuals i.e., short sleepers (which need 6 h of sleep or less) and the long sleepers (which need 8 h of sleep or more) [29]. One result that causes concern is the large percentage of both men (50%) and women (63%) who sleep between 5 and 6 h per night, which is less than the minimum recommended for healthy adults (7 to 9 h) [16]. This result is even more worrying when considering that the respondents are athletes who require more sleep time per night than normal adults to ensure adequate recovery [16].

Furthermore, evidence exists that athletes who sleep for more than 8 h per night experience more performance benefit [16]. Thus, the data provides evidence that men and women who practice triathlon recreationally, sleep less than that recommended amount for good health and physical performance. It is important to point out that reduced number of hours of sleep has been associated with overtraining syndrome, increased rates of illness and musculoskeletal injuries [30]. Moreover, it has been demonstrated that even a single night of disturbed sleep may impair recovery from high-intensity training, including a reduction in peak power out and diminished motivation to train in elite cyclists [31].

Overtraining syndrome symptoms are multisystem and often include hormonal, immunologic, neurologic, and psychologic disturbances in response to excessive exercise without adequate rest [20]. The diagnosis of the overtraining syndrome is complicated by the retrospective nature of its definition: It is a state of performance decrease that requires many

Table 4
Absolut and perceptual values for male and female athletes.

Variables	Male *N* = 80	Female *N* = 19	χ^2 value and p value	Cramer's V
Sleeping hours per night				
4 – 6 h/night	40 (50%)	12 (63%)	$\chi^2 = 1.07$, $p = 0.30$	0.10
7 – 8 h/night	40 (50%)	7 (37%)		
Loss of energy in the last week				
Yes	22 (28%)	8 (42%)	$\chi^2 = 1.55$, $p = 0.21$	0.12
No	58 (72%)	11 (58%)		
Loss of recently unintentional weight				
Yes	10 (12%)	2 (10%)	$\chi^2 = 0.56$, $p = 0.82$	0.02
No	70 (88%)	17 (90%)		
Performance decrease in the last week				
Yes	6 (7%)	4 (21%)	$\chi^2 = 3.10$, $p = 0.08$	0.17
No	74 (93%)	15 (79%)		
Previous experience in Ironman race				
Yes	58 (72%)	8 (42%)	$\chi^2 = 6.38$, $p = 0.01$	0.25
No	22 (28%)	11 (58%)		
Total training hours per week				
until 11 h/week	6 (7%)	1 (5%)	$\chi^2 = 0.66$, $p = 0.72$	0.08
12–14 h/week	18 (23%)	6 (31%)		
15–17 h/week	22 (27%)	2 (11%)		
18–20 h/week	8 (10%)	4 (21%)		
More than 20 h/week	26 (33%)	6 (32%)		
Swimming training hours per week				
1–2 h/week	20 (25%)	5 (26%)	$\chi^2 = 4.31$, $p = 0.23$	0.20
3–4 h/week	42 (52%)	8 (43%)		
5–6 h/week	10 (13%)	5 (26%)		
7–8 h/week	0 (0%)	1 (5%)		
9–10 h/week	2 (2%)	0 (0%)		
More than 10 h/week	6 (8%)	0 (0%)		
Cycling training hours per week				
Until 4 h/week	6 (7%)	1 (5%)	$\chi^2 = 0.43$, $p = 0.81$	0.06
5–6 h/week	10 (13%)	3 (16%)		
7–8 h/week	31 (39%)	8 (42%)		
9–10 h/week	17 (21%)	4 (21%)		
More than 10 h/week	16 (20%)	3 (16%)		
Running training hours per week				
3–4 h/week	31 (39%)	7 (37%)	$\chi^2 = 1.07$, $p = 0.58$	0.10
5–6 h/week	33 (41%)	9 (47%)		
7–8 h/week	5 (6%)	2 (11%)		
9–10 h/week	3 (4%)	1 (5%)		
More than 10 h/week	8 (10%)	0 (0%)		

months in the setting of proper rest [21], therefore, the presence of overtraining syndrome was not evaluated in the present study. Instead, only some common overtraining symptoms, such as unintentional weight loss, feeling of fatigue and perception of performance decrease were asked. Curiously, a significant percentage of athletes reported unintentional body mass loss (12% of men and 10% of women), a feeling of lack of energy (28% of men and 42% of women), or a performance decrease (7% of men and 21% of women) forty days before the race. As expected, the presence of any of these symptoms was correlated with a worse performance characterized by a higher overall race time. Furthermore, the most frequent symptom, a reported lack of energy, showed a correlation with performance decrease in splits (swimming, cycling, and running) and also in overall race time. Thus highlighting the importance for trainers to be especially careful and attentive to the occurrence of these symptoms in their athletes.

Finally, the last evaluated parameter that shows to be essential to performance is the previous experience in an Ironman race. This data was in accordance with previous data[6]. The authors have shown that the more familiarity and experience with previous Ironman competitions positively impacts the performance of the triathlete [6]. The present results showed that previous experience is especially important for swimming performance and overall race time.

According to performance stratified by sex, men performed significantly better in swimming and in the overall race time in comparison to women. In running and cycling, the performance between sexes was not significantly different. Still, when comparing sexes, it was observed that men and women train approximately the same quantity of hours of swimming, cycling and running per week. In addition, the frequency of overtraining symptoms, such as unintentional body mass loss, perception of fatigue, and performance decrease were similar between sexes. The only significant difference between sexes observed was related to the previous experience in Ironman races. There was a higher percentage of men who had already participated in an Ironman race previously. Considering that the greater experience positively impacts the performance of the triathlete [6], especially in swimming and overall time, it is possible that the difference in performance observed between the sexes can be, at least partially, attributed to the difference in experience in Ironman races. Besides the known physiological differences between sexes.

A limitation of the present study is that it was a cross-sectional study, therefore no causal relationships can be performed, moreover the assessed data was self-reported, and there may be a bias towards data reliability. In addition, the questionnaire was answered one month before the race and the volunteers were asked to answer according to what they did / felt in the previous week, therefore, the conclusions should be limited to this period. The representativeness of the data also may be consider a study limitation once only 7.7% of the participantes on the Brazil Ironman race (2019, May) participated in the study (7.0% of the male and 10% of the female competitors). Another limitation is the different sample sizes of male and female participants of the study. Although the different number of women and men who participated in the study be a limitation, having a sample of 19 women who completed Ironman is also one of the strengths of the study given the scarcity of data on the female sex, mainly in Ironman triathlon distance. Finally, as the overtraining syndrome is a complex and multisystem syndrome that often includes hormonal, immunologic, neurologic, and psychologic disturbances characterized by having a complicated diagnosis considering the retrospective nature of their definitions, only some common symptoms present in overtraining syndrome have been evaluated.

5. Practical applications

According to the practical application, coaches should be aware of symptoms associated with overtraining syndrome, especially when athletes report fatigue, once many hours of training per week, forty days before a race, are not associated with a better performance, but the fatigue symptom is. Future longitudinal studies may investigate if the high training volumes that have been recommended for elite athletes to improve aspects traditionally known as determinants of performance, such as $\dot{V}O_{2max}$, AT, or running economy, also positively affect these variables and the triathlon performance in amateur triathletes.

6. Conclusion

Amateur triathlon performance in swimming split and overall race time in Ironman distance were not different among those who performed different weekly training hours (between 9 and 20 h per week) forty days before a race. Moreover, the presence of unintentional loss of

weight, fatigue sensation, or performance decrease, may negatively impact triathlon performance.

Declaration of Competing Interest

The authors declare no conflict of interest.

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