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Relationship Between Training Volume and Ratings of Perceived Exertion in Swimmers

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Abstract
The markers of external training load (ETL), distance and intensity, do not take into account the athletes' psychophysiological stress, i.e., internal training load (ITL). Thus, the aim of this study was to evaluate the relationship between ETL and ITL using the rating of perceived exertion (RPE) and session-RPE in swimmers. Seventeen young swimmers (10 male, 15.8 ± 0.87 yr and 7 female, 15.1 ± 0.46 yr) belonging to one national level youth team took part in this study over 4 wk. The external training

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load was planned using swimming distance (in meters) at seven different training intensities. Swimmers' RPE was assessed 30 min after each training session. Session-RPE was calculated by multiplying RPE by session duration (min). The relationship between the variables was analyzed with Pearson correlations and a multiple linear regression was performed to predict the session-RPE as a function of the independent variables (aerobic and anaerobic volume). The swimming distance at different intensities correlated strongly with RPE and very largely with session-RPE (.64, $p < .05$ and .71, $p < .05$, respectively). Regression analysis indicated that the aerobic and anaerobic volumes together explained more than 50% of the ITL variability. In conclusion, the swimming distance in each training session was significantly associated with RPE and session-RPE in swimmers. In other words, based on these results, the use of high-volume training at lower intensities affects the RPE and Session-RPE more than the anaerobic volume.

Keywords

swimming, training volume, RPE-session, sports training

Introduction

The training load in swimming is traditionally prescribed and monitored using distance covered (i.e., meters covered), swimming velocity and the recovery between series or laps, i.e., swimming 10×100 m, at a 1:40 min interval (Wallace, Slattery, & Coutts, 2009) as indicators of training volume and intensity, respectively. Nevertheless, these markers of external training load do not take into account the psychophysiological responses elicited by the exercise. Several methods have been proposed to quantify this internal training load (ITL), using physiological or perceptual measures of exertion. Heart rate, oxygen uptake (VO_2) (Impellizzeri, Rampinini, & Marcora, 2005), adrenaline and cortisol (Viru & Viru, 2000), blood lactate and session rating of perceived exertion (session-RPE) (Impellizzeri, Rampinini, Coutts, Sassi, & Marcora, 2004; Wallace et al., 2009; Milanez, Pedro, Moreira, Boullosa, Salle-Neto, & Nakamura, 2011) have been comonly used to quantify the ITL and its associated physiological responses in different sports. This approach could provide important information for promoting adequate training quantities to improve performance and avoid excessive accumulation of fatigue and subsequent overtraining (Impellizzeri et al., 2005; Coutts, Reaburn, Piva, & Murphy, 2007; Coutts, Wallace, & Slattery, 2007; Freitas, Nakamura, Miloski, Samulski, & Bara-Filho, 2014). It has been suggested that the traditional monitoring methods for quantifying the external training load in swimming could be complemented by monitoring ITL to optimize periodization. However, to date this is not a common practice in this sport discipline.

During the last decade, the session-RPE has emerged as a low cost and practical method of monitoring ITL (Foster, Florhaug, Franklin, Gottschall, Hrovatin, Parker et al., 2001). In this method, the ITL is quantified as the product between the rating of perceived exertion (RPE) obtained using a 10-point scale (CR-10) (Borg, Hassmen, & Lagerstrom, 1987) and the duration of the training session in minutes (Foster et al., 2001). The session-RPE method has been validated for use in several sports such as volleyball (Bara Filho, Andrade, Nogueira, & Nakamura, 2013), interval cycling exercise and basketball (Foster et al., 2001), taekwondo (Haddad, Chaouachi, Wong del, Castagna, Hue, Impellizzeri et al., 2014), soccer (Impellizzeri et al., 2004; Scott, Lockie, Knight, Clark, & Janse de Jonge, 2013) and swimming (Wallace et al., 2009; Psycharakis, 2011) since it correlates well with other heart rate (HR)-based methods. Despite moderate to large correlations reported between session-RPE and HR-based methods (Foster et al., 2001; Impellizzeri et al., 2004; Bara Filho et al., 2013; Scott et al., 2013; Haddad et al., 2014), session-RPE has been suggested as the most suitable method to monitor ITL in swimming, due to the high-intensity exercises performed in this discipline and the noise associated with underwater HR monitoring (Wallace et al., 2009).

Some studies (Impellizeri et al., 2005; Milanez et al., 2011) have shown that ITL results from the interaction between ETL and individual features. Thus, the same ETL may not induce the same psychophysiological stress (internal load) in different athletes (Barroso, Salgueiro, do Carmo & Nakamura, 2015). To understand how ETL relates to the session-RPE method and to test its suitability, the correlation between the traditional method of quantifying ETL (i.e., swimming distance) and the session-RPE method should be ascertained. In soccer players, the total distance covered during training was highly correlated with session-RPE ($r = .71$; $p < .01$) (Scott et al., 2013). Similar results were found in Australian Football players ($r = .81$; $p < .05$) (Scott, Black, Quinn, & Coutts, 2012). In swimmers, the total training distance significantly correlated with session-RPE ($r = .37$–$.81$; $p < .05$) during a period of high-intensity interval training programs (Wallace et al., 2009). However, the relationship between swimming distance and session-RPE is poorly understood, especially when segmented into different intensity zones typical of swimming training.

According to Marcora (2009), perceived exertion is sourced from a "sense of innervations" suggested more than 150 yr ago as follows: the sense of effort is generated from processing of corollary discharges from premotor and motor areas of the cortex to (Marcora, 2009). The RPE was originally proposed by Borg (1962) and demonstrated high correlation (.77–.90) with heart rate during the validation process. Therefore, the method was shown to be a good indicator of physiological work intensity performed by athletes (Skinner, Hutsler, Bergsteinová, & Buskirk, 1973). According to Foster et al. (2001), the measured post-exercise RPE value is a single global rating of the intensity, which can be multiplied by a volume variable (i.e., time in minutes) to calculate sessional training load (session-RPE). Indeed, studies with different sports disciplines have suggested that the training volume does not influence or has a small influence on RPE values (Green, McIntosh, Hornsby, Timme, Gover, & Mayes, 2009; Haddad et al., 2014). However, Barroso et al. (2015) assessed swimmers' ITL after standardized sets of interval swimming training, and their results indicated that RPE is affected not only by the intensity but also by the volume of training. Therefore, the conflicting results shown in different sports lead us to investigate whether training volume (i.e., distance covered) in some way influences the RPE values reported by swimmers after the training session.

The aim of this study was to test the correlations between total swimming distance and swimming distance covered at different intensity ranges (i.e., external training load) and the RPE and session-RPE (i.e., ITL) in elite young swimmers. Based on previous studies (Wallace et al., 2009; Barroso et al., 2015), it was hypothesized that the ETL variables would be highly correlated with the ITL. Furthermore, training volume may influence RPE, since high training volumes are commonly applied in swimming. Wallace et al. (2009) reported that swimmer's training sessions can last for more than 90 min and swimmers can cover up to 6 km per session.

Method

Participants

Seventeen young swimmers (10 male, 15.8 ± 0.87 yr, weight 64.7 ± 3.2 kg and height 175.3 ± 4.3 cm; and 7 female, 15.1 ± 0.46 yr, weight 54.8 ± 3.7 kg and height 167.2 ± 5.1 cm), belonging to one swimming team competing at national level, took part in this study. The team was ranked in the top-5 Brazilian teams in the year of the study. To be included in the study, swimmers had to be registered with the Brazilian Confederation of Aquatic Sports, aged less than 16 yr and have been training for at least 2 yr. The exclusion criteria were: occurrence of injury or diseases (i.e., infection in upper respiratory tract) during the course of the study and use of illegal substances that could influence performance. The study was approved by the Ethics Committee in accordance with the Declaration of Helsinki. All procedures were explained to the athletes and responsible persons who signed an informed consent form.

Procedure

The training was planned by the swimming team staff without the involvement of the researchers (Table 1). The training periodization was based on the ATR model (Issurin & Kaverin, 1985), in which the training was divided into accumulation, transformation and realization mesocycle blocks. The internal and

Table 1. External Training Load: Schedule of Swimming Periodization Based on Distance Covered in Meters (m).

Week	Training Intensities	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Total week distance (m)
1	A0	800	1200	1200	800	1300	800	6100
	A1	2900	600	1600	2400	1500	2900	11900
	A2	1700	3000	1200	1200	300	1000	8400
	A3	1200	1200	0	0	300	0	2700
	LT	0	0	0	1800	0	400	2200
	LP	0	0	0	0	100	200	300
	S/P	0	200	600	200	1400	0	2400
2	A0	800	1000	500	0	950	0	3250
	A1	2900	2600	600	2000	400	0	8500
	A2	1900	0	100	1000	0	0	3000
	A3	1400	900	100	0	0	0	2400
	LT	0	0	300	0	350	0	650
	LP	0	0	0	0	0	0	0
	S/P	0	100	550	0	250	0	900
3	A0	1300	400	500	1000	700	2200	6100
	A1	1600	2400	1200	2300	3400	400	11300
	A2	0	0	2200	800	200	0	3200
	A3	600	600	600	200	200	0	2200
	LT	200	900	0	100	0	0	1200
	LP	0	0	0	0	0	0	0
	S/P	0	200	0	0	75	200	475
4	A0	200	0	0	0	0	0	200
	A1	2700	0	0	0	0	0	2700
	A2	200	0	0	0	0	0	200
	A3	200	0	0	0	0	0	200
	LT	0	0	0	0	0	0	0
	LP	0	0	0	0	0	0	0
	S/P	200	0	0	0	0	0	200

Note. Week days are abbreviated Mon., Tues., Wed., Thurs., Fri., Sat. Aerobic volume: A0 – low intensity; A1 – moderate intensity; A2 – high intensity; A3 – severe intensity; Anaerobic volume: LT – lactate tolerance; LP – lactate production; S/P – speed and power.

external training loads were monitored during 18 training sessions over four successive weeks. The first and second weeks (i.e., pertaining to the transformation mesocycle block) encompassed 6 and 5 training sessions, respectively, and the third and fourth weeks (i.e., pertaining to the realization mesocycle block) encompassed 6 and 1 training sessions, respectively. Only one session was monitored in the fourth week because the swimmers traveled to a championship. This training cycle preceded the Brazilian Youth Swimming Championship. During the weekends, before the first training day and between the second and third weeks, the athletes attended regional (preparatory) championships.

Monitoring of External Training Load

The external training load was planned using swimming distance (in meters) at seven different training intensities: A0 – swimming at low intensity (i.e., warm-up, cool-down and recovery training –blood lactate concentration: <2 mmol/L); A1 moderate intensity (i.e., 2 to 4 sec/100 m slower than anaerobic threshold – blood lactate concentration: 2 to 3 mmol/L); A2 high intensity (i.e., at anaerobic threshold –blood lactate concentration: 3 to 5 mmol/L); and A3 severe intensity (i.e., 1 to 2 sec/100 m faster than anaerobic threshold –blood lactate concentration: 6 mmol/L or more); lactate tolerance (i.e., maximal, working in anaerobic lactic system –blood lactate concentration: up to 25 mmol/L); lactate production (i.e., 5 sec/100 m faster than anaerobic threshold –blood lactate concentration: up to 25 mmol/L); and speed and power (maximal, working in anaerobic alactic system – ATP-CP) (Maglischo, 2010). The anaerobic threshold refers to the second metabolic threshold (blood lactate concentration = ~4 mmol/L).

The swimming distance covered in A0 + A1 + A2 + A3 were totaled to quantify the "aerobic" volume in each session. The swimming distance covered in lactate tolerance + lactate production + speed and power were totaled to quantify the "anaerobic" volume. All swimming distances covered in each session were totaled to quantify the total volume. This is a method proposed by Maglischo (1999, 2010), widely used in swimming to quantify the intensity of the exercises based on the swimming speed.

Monitoring of Internal Training Load

The ITL was monitored using the RPE and session-RPE methods (Foster et al., 2001). Thirty minutes after each training session, in their own training environment, swimmers indicated their training intensity using a standardized perceived exertion scale (CR-10) (i.e., 0: rest to 10: maximal) (Borg et al., 1987). The value indicated by the swimmers was multiplied by the duration time, in minutes, of each training session to quantify the ITL in arbitrary units, which represented the session-RPE values. This method was validated for swimming by Wallace et al. (2009). The responses to the CR-10 scale were collected by the researchers, without the technical staff interfering. The athletes were familiarized with the method prior to commencing the research.

Statistical Analysis

The descriptive analysis is presented as means ± standard deviations. Normality and homoscedasticity of the data were checked using the Shapiro-Wilks and Levene's tests, respectively. To compare the differences in internal training load between the two mesocycles, Student t test was applied. A two-way was performed to analyze the differences between groups for internal training load according to the sex of the participants for each mesocycle block (transformation and realization) followed by Tukey post hoc test. The relationship between the internal and external training loads were analyzed with Pearson correlations, according to the criteria proposed by Hopkins (2002) as follows: <.10 (trivial), from .10 to 0.30 (low), .31 to .50 (moderate), .51 to .70 (high), .71 to .90 (very high), .91 to .99 (near perfect) to 1.0 (perfect). Multiple linear regression, using the Enter method, was performed to obtain a parsimonious model, which allowed prediction of the internal load in arbitrary units (session-RPE) as a function of the independent variables (aerobic volume and anaerobic volume). For all analyses, the statistical package IBM SPSS Statistics for Windows (IBM Corp., 2010), Version 19.0 was used with a significance level of 5%.

Results

The external training load and internal training load (i.e., RPE and session-RPE) over the observation period are described in Tables 1 and 2, Figure 1a and 1b. The average RPE over the 18 training sessions was 3.4 ± 1.9, and the most frequent RPEs reported were 1 and 2 (42%). No significant differences were found when the RPEs were compared across sexes ($t = 1.8$, $p = .06$). In the first 11 sessions pertaining to the transformation mesocycle block, the Student t test showed that the RPEs were higher than in the other sessions (i.e., Sessions 12–18, pertaining to the realization mesocycle block) (4.2 ± 0.3 vs. 2.2 ± 0.4; $F = 9.61$, $p < .01$, $\eta^2 = 5.71$). The same was observed in session-RPE values

Table 2. RPE and Session-RPEs in Each Mesocycle Block By Sex.

	RPE ($M \pm SD$)		Session-RPE ($M \pm SD$)	
	Female athletes	Male athletes	Female athletes	Male athletes
Total	3.42 ± 1.8	3.35 ± 1.6	333.1 ± 240.1	337.4 ± 261.6
TB	3.99 ± 1.7†	4.31 ± 1.8	407.2 ± 234.1†	436.8 ± 236.3
RB	2.44 ± 0.4	2.02 ± 0.4	207.2 ± 81.7	180.7 ± 57.4

Note. RPE given in "arbitrary units"; TB – Transformation Block; RB – Realization Block.
†Statistically different from males ($p < .05$).

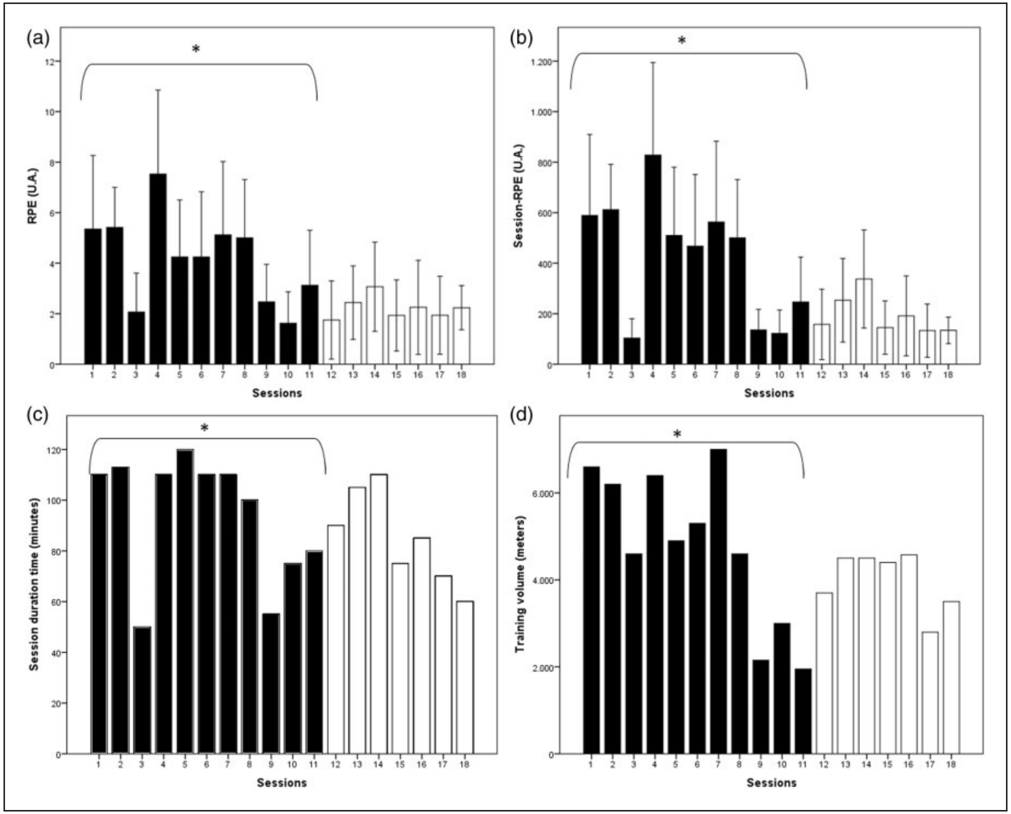

Figure 1. a. Rating of perceived exertion (RPE), b. Session-RPE, c. Session duration time; d. Training volume (swimming distance) of 18 swimming training sessions (means $\pm$ standard deviations). White bars represent the realization block and black bars, the transformation block. In the first 11 sessions pertaining to the transformation mesocycle block, the RPEs were higher than in the other sessions from realization block (4.2 ± 0.3 vs. 2.2 ± 0.4; $F = 9.61$, $p < .01$, $\eta^2 = 5.71$). The same was observed in session-RPE values (425.6 ± 259.9 vs. 191.7 ± 97.0; $F = 12.33$, $p \leq .01$, $\eta^2 = 1.31$) and the average session-RPE over the 18 training sessions was 333.2 ± 240.1.

(425.6 ± 259.9 vs. 191.7 ± 97.0; $F = 12.33$, $p \leq .01$, $\eta^2 = 1.31$) and the average session-RPE over the 18 training sessions was 333.2 ± 240.1.

When the RPEs were compared by sex and periods (Table 2) the two-way ANOVA showed differences between sexes ($F = 5.1$, degree of freedom = 1, $p = .03$, $\eta_p^2 = 0.04$), periods ($F = 107.8$, degree of freedom = 1, $p < .01$, $\eta_p^2 = 0.50$) and interaction sexy and period ($F = 11.9$, degree of freedom = 1, $p < .01$, $\eta_p^2 = 0.10$). The post-hoc test showed significant differences when RPEs were compared by sex in the transformation mesocycle block ($p < .01$). However, no significant differences were found between the RPE of female and male athletes in the realization mesocycle block ($p = .69$).

When the session-RPEs were compared by sex and periods the two-way ANOVA showed differences between sexes ($F = 9.1$, degree of freedom = 1, $p < .01$, $\eta_p^2 = 0.07$), periods ($F = 90.6$, degree of freedom = 1, $p < .01$, $\eta_p^2 = 0.45$) and interaction sexy and period ($F = 12.7$, degree of freedom = 1, $p < .01$, $\eta_p^2 = 0.10$). The post-hoc test showed significant differences when session-RPE were compared by sex in the transformation mesocycle block ($p < .01$). However, no significant differences were found between the session-RPE of female and male athletes in the realization mesocycle block ($p = .82$).

Neither the session duration nor the external training load was statistically different for all athletes of each session. The session duration time ranged between 60 and 120 min. The swimming distance of each training session is described in Table 3, Figures 1c and 1d, respectively.

The correlation between training volume (i.e., swimming distance) and session-RPE and RPE are reported in Table 4. The session-RPE presented a very high correlation with total volume, high correlation with aerobic volume and moderate correlation with A2, A3 and anaerobic volume. RPE presented a large

Table 3. Session duration and swimming distance at each training intensity.

	M	*SD*	Range
Duration (min)	90.0	22.2	50–120
Total volume (m)	4475	1445	1950–7000
Total Aerobic volume (m)	3954	1507	
A0 (m)	957	347	
A1 (m)	1788	562	
A2 (m)	792	851	
A3 (m)	417	462	
Total Anaerobic volume (m)	496	632	

Note. Aerobic volume: A0 – low intensity; A1 – moderate intensity; A2 – high intensity; A3 – severe intensity.

Table 4. Correlations Among Session-RPE, RPE and Indicators of External Training Load.

	Session-RPE	RPE
Total volume	.71*	.64†
Aerobic volume	.58*	.50†
A2 volume	.45*	.40*
A3 volume	.43*	.37†
Anaerobic volume	.35*	.34†

*$p < .05$. †$p < .01$.

Table 5. Regression Statistical Information.

Variable	B	SE	B	*t*	*p*
Aerobic volume	0.112	0.006	0.71	17.40	<.001
Anaerobic volume	0.208	0.015	0.55	13.49	<.001
Adj R^2					.60
$F(2,256)$					194

correlation with total volume and moderate correlation with aerobic volume, A2, A3 and anaerobic volume.

The multiple linear regression indicated that aerobic volume and anaerobic volume interfered in ITL monitored through the session-RPE method. Table 5 indicates that the combination of independent variables explained more than 50% of the ITL variability.

Discussion

The main result found in the present study was that the swimming distance at different intensities significantly correlated with RPE and session-RPE, and that the total swimming distance in each training session was highly correlated with RPE and with session-RPE. Furthermore, the aerobic and anaerobic volumes were significant predictors of ITL on regression analysis. These results suggest that the training volume in swimming (i.e., swimming distance) influences RPE and session-RPE.

An important aspect to be highlighted in this study is the difference found between the internal load variables when comparing athletes of both sexes in the transformation mesocycle block. Previous research concluded that female swimmers have more economic swimming styles than men due to anthropometric characteristics, such as increased body density and lower hydrodynamic torque (Onodera, Miyachi, Yano, & Yano, 1999; Barbosa, Fernandes, Keskinen, Colaço, Cardoso et al., 2006; Caspersen, Berthelsen, Eik, Pâkozdi, & Kjendlie, 2010), factors that could positively affect energy expenditure in swimming. Accordingly, the present study showed that male athletes presented higher perceived exertion during the transformation mesocycle block than females (436.8 vs. 407.2, respectively), which indicates the importance of individual characteristics in the actual physiological stress imposed on young swimmers of both sexes by the same external training load. However, to see if these differences are associated with positive adaptations for both sexes, future studies are suggested, relating male and female internal training loads with athletic performance.

The correlation between distance covered during exercise and session-RPE has been reported in other studies (Casamichana, Castellano, Calleja, Roman, & Castagna, 2013; Lovell, Sirotic, Impellizzeri, & Coutts, 2013; Scott et al., 2013). Large correlations were shown between distance covered and session-RPE in soccer players, in Australian Football and in rugby players, corroborating the results found in the present study (Casamichana et al., 2013; Lovell et al., 2013; Scott et al., 2012). A large correlation was reported between the session-RPE and swimming distance in swimmers during a period of high-intensity training (Wallace et al., 2009). However, the individual correlations showed that some swimmers had lower correlations between swimming distance and session-RPE ($r = .37–.85$), suggesting that in high-intensity training swimming distance may not be an accurate measure for monitoring training load. In the present study, the percentage of swimming distance in each session performed at low intensity (i.e., A0 + A1) was high, and swimmers reported RPE values of 1 and 2 at a frequency of 42% across all training sessions, suggesting that the characteristic of training was substantially different to the aforementioned study with swimmers (Wallace et al., 2009). It suggests that in swimming training sessions in which intensity is low, the volume of training may be associated with session-RPE. There is a higher association between aerobic volume and session-RPE ($\beta = 0.71$), when compared with anaerobic training volume ($\beta = 0.55$), which reinforces the stronger association between high training volume at low intensity on session-RPE found in the present study.

The regression analyses suggested that all the independent variables together explained more than 50% of the ITL variability. Nevertheless, it is noteworthy that the physical training itself, as measured by these components (aerobic and anaerobic volumes), accounted for only half the variance in ITL and that other unmeasured and unidentified variables accounted for an equivalent amount. The regression analysis focused on the ETL (i.e., distance covered at different intensities) and ITL. However, there could be other important factors that are associated with changes in perceived exertion throughout the season, probably psychological and emotional factors. For example, Marcora, Staiano and Manning (2009) indicated that mental fatigue affects the RPE values and, in consequence, physical performance in a cycle-to-exhaustion protocol. Therefore, coaches and athletes should consider the psychophysiological factors as important as the external training loads (Borresen & Lambert, 2008), since they can be linked to fluctuations in ITL during the season. Further research is necessary to investigate these variables and their relationship with RPE and session-RPE.

The large correlation between total swimming distance in each session and RPEs reported by swimmers is a notable finding. Prior studies have found low or no correlation between training duration and RPEs in sports with different demands and metabolic profiles such as taekwondo (Foster et al., 2001; Green et al., 2009; Haddad et al., 2014). However, they found moderate correlation between RPEs and time spent at high intensity (i.e., 91 and 100% of the maximal HR) in taekwondo training sessions (Haddad et al., 2014). Only 10% of the taekwondo training time was spent at high intensity, suggesting that the volume of training at high intensity can influence RPE. Specifically in swimming athletes, Barroso et al. (2015) found differences in RPE according to the training volume. Athletes who performed 10×100 m presented lower session RPEs than those who performed 20×100 m ($p < .05$). These results reinforce the association between perceived exertion and volume in swimmers.

Other results found in the present study showed moderate correlation between RPE values and anaerobic volume. However, the results also showed correlations between RPEs and other intensities of training zones. It is possible that long duration training can decrease glycogen reserves and influence RPEs (Haddad et al., 2014). Swimmers covered between 1950 and 7000 m and spent 50 to 120 min on each training session and usually performed laps such as 4×200 m plus 8×150 m, 8×250m, 24×100 m, 4×300 m plus 5×200 m. In the present study training sessions monitored in the first 2 wk corresponded with the end of the transformation mesocycle block, which aims to increase stress and provide little recovery (Issurin & Kaverin, 1985). Therefore, the higher volume of training in this block and the proximity of the Brazilian championship could have promoted an accumulated fatigue in the swimmers and increased the influence of the volume of training sessions on the perception of effort. The Brazilian Youth Swimming Championship is the most important competition of the year for these athletes and the proximity of this competition could have affected their emotions and outlook, thus generating an increase in stress, despite the decrease in external training load (Nogueira, Nogueira, Miloski, Cordeiro, Werneck, & Bara Filho, 2015). It is known that athletes who show fatigue accumulation report higher values on the RPE scale (Wallace et al., 2009; Psycharakis, 2011).

It is interesting to report the high volume of training performed by swimmers in the present study. High volume of training has been traditionally periodized in swimming, with distances covered of $\sim$70 to 100 km each week (Costill, Fink, Hargreaves, King, Thomas, & Fielding, 1985; Mujika, Lacoste, Barale, Geyssant, & Chatard, 1996; Termin & Pendergast, 2000). This has been reflected in a frequent occurrence of overtraining in this sport, besides the monotony of training due to the large volumes and times spent at the same intensity (Gonzalez-Boto, Salguero, Tuero, Gonzalez-Gallego, & Marquez, 2008; Rohlfs, Mara, Lima, & Carvalho, 2005). Thus, it is important to question whether this is the best strategy for planning training. In addition, based on these results and those of other studies (Wallace et al., 2009; Psycharakis, 2011), the problem is not just the high volume of training, but inadequate distribution of loads during the season. Periods at high volume can and should be used provided that they are alternated with recovery periods as a better way of organizing the training loads.

Limitations and Conclusion

This study has some limitations such as the lack of monitoring of the athletic performance as well as the absence of a physiological method to monitor the athletes' physical conditioning, the low number of participants and limited number of sessions. Accordingly, future studies in this area should add a physiological measure in addition to more sessions. Also future studies could investigate whether accumulated fatigue in swimmers can influence RPE values.

In summary, the swimming distance in each training session was significantly associated with RPE and session-RPE in swimmers. In other words, based on these results, the use of high-volume training at aerobic intensities affects the RPE and session-RPE more than the anaerobic volume. Thus, this suggests that coaches should use both methods to prescribe (i.e., external training load) and monitor (i.e., internal training load) training in swimmers due to the influence of the external training load on the session-RPE method.

Declaration of Conflicting Interests

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