Effects of an experimental taper period on male and female swimmers

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Title: Effects of an experimental taper period on male and female swimmers

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ABSTRACT

BACKGROUND: This study investigated the possible influence of the gender on the responses of swimmers during a taper period (TP). **METHODS**: Ten males (19 ± 3 years and 73.5 ± 7.8 kg) and ten females (17 ± 2 years and 54.7 ± 7.2 kg) swimmers were submitted to a 12-week training, followed by three weeks of the TP. Before and after the TP we evaluated the performance at 100 m freestyle, stroke parameters and lactacidemic responses; lactate minimum intensity (LMI) and stroke parameters associated with LMI and the propulsive force in tethered swimming. TP consisted of 14 sessions with mean volume 2,253 ± 1,213 m•session^{-1} at an intensity below than the LMI, 1,730 ± 327 m•session^{-1} at an intensity near the LMI and 1,530 ± 1,019 m•session^{-1} at an intensity above the LMI. **RESULTS**: Significant effects of the genders were observed for LMI and stroke parameters (p-value < 0.001 and $\eta^2 > 0.52$ [large]) and propulsive force (p-value = 0.001; η2 = 0.59 [large]). However, no significant effects of the TP were identified in the performance of the 100 m freestyle (p-value = 0.66; $\eta^2 = 0.006$ [small]), propulsive force (p-value > 0.63; $\eta^2 < 0.006$ [small]), aerobic parameters (LMI: p-value = 0.32 and η^2 = 0.03 [small]) and mechanical parameters (p-value > 0.23; $\eta^2 = 0.01$ [small]). Nonetheless, the peak blood lactate concentrations were improved after TP (p-value = 0.014; $\eta^2 = 0.16$ [large]), without significant interactions (p-value = 0.38; $\eta^2 = 0.02$ [small]), as well as the mechanical parameters during maximum 100 m freestyle (p-value < 0.04 and $\eta^2 > 0.10$ [medium]). **CONCLUSIONS**: Hence, men and women presenting significantly different values in the age group studied, the responses observed after the TP investigated were the same independent of gender.

Keywords: gender difference, anaerobic threshold, swimming, performance, stroke, science sports

INTRODUCTION

The typical model of training in swimming has been divided into a basic preparatory period (BP), specific preparatory period (SP) and taper period (TP) [1, 2]. Commonly, this planning is characterized by the high volume of training in the BP, followed by an exponential increase in intensity with an emphasis on the specificity of the event of interest (e.g., SP)[1, 3-5]. After these training phases, the taper period occurs, characterized by the maintenance of the intensity with a decrease in the training volume, characterized by the maintenance, recovery and, later, a super compensation of the gains obtained throughout the season[1, 3, 4]. In that manner, theoretically, the polishing period allows the most significant performance during the competition, indicating the key importance of this period for the ultimate outcome of a periodization in swimming[2-4].

Nonetheless, responses to stimuli applied during TP can be different between men and women due to the differences in physiological, anthropometric, hormonal and genetic variables between genders[6-8]. Precisely, women have a higher body fat content[9] and men possess a more significant volume of muscle mass[10]. These innate characteristics seem to influence swimming in numerous ways, where women are more economical than men because they contain a lower density and better buoyancy[11, 12] and consequently may present lower values of blood lactate concentrations [La^-][13]. Men have higher values of strength, power and [La^-] due to a greater amount of muscle mass[10, 13, 16] and higher levels of testosterone[14, 15]. Notwithstanding, men have greater relative and absolute aerobic power than women[6], because the cardiovascular and respiratory function are further improved (i.e., lower heart rate and blood pressure; higher ventilation and lower maximum respiratory rate)[6]. Considering these physiological and morphological characteristics, the same training stimulus can induce different responses between genders. Therefore, understanding these differences during a training period is extremely important for the success of an applied periodization for men and women.

In fact, previous studies sought to verify the responses of these variables induced by TP models in swimmers' performance[6, 16-18]. However, to the best of our knowledge, only Santhiago and colleagues[16] monitored the haematological responses and aerobic performance in men and women during a training period and observed no differences in the anaerobic threshold in the invasive method, yet they found performance improvements in the 100 m freestyle in both genders at the end of TP in relation to the other phases of the training program. Therefore, we can say that the information about the gender difference regarding the behaviour of these parameters and their interaction with the performance in the short distance swimming events under the influence of a training period and especially the typical taper period in swimming is limited. Hence, the aim of this study was to investigate the response of physiological, biomechanical, propulsive force, and performance parameters and their interactions in male and female swimmers in an experimental taper period. We expect a difference in the responses of the variables of interest between the genders. However, the period of experimental training does not cause differences between them.

METHODS

Twenty young swimmers volunteered for this study (19.0 ± 3.0 years and 66.5 ± 16.0 kg), including ten men (19 ± 3 years and 73.5 ± 7.8 kg) and ten women (17 ± 2 years and 54.7 ± 7.2 kg). These athletes trained an average of five times a week, with a mean volume of 21,400 ± 7,100 m•week^{-1} and the performance level for a 100 m freestyle in a 25 m swimming pool was expressed as a percentage of the world record (78.6% for males and

71.9% for females) according to the FINA 2020. All swimmers had at least three years' experience competing in short/medium distance events, at state and national level. They were part of a team in which the study group performed monitoring and physiological support throughout the season. Thirty swimmers were recruited, but those who performed all evaluations were selected for analysis. The athletes were informed about all experiments, procedures, risks and benefits of participating in the present study. All procedures were performed in accordance with the Declaration of Helsinki, and the local university ethics committee approved the protocol. [BLIND FOR REVIEW PURPOSE].

Experimental design

The athletes were submitted to a training program composed of a 15-week macrocycle. The training program was developed by the team's trainers without any external interference. Two evaluations were conducted, before and after the TP. All the evaluations were divided over two days. On the first day, a 100 m freestyle maximum performance and lactate minimum test were carried out to determine the peak blood lactate concentration ($[La^-]_P$) and lactate minimum intensity (LMI). The LMI was used to monitor the session intensity during the TP. On the second day, a 30 secs all-out effort was performed in tethered swimming, to determine force parameters. All swimmers were familiarized with all the procedures. All the test sessions were performed after a typical standardized warm up (1,000 m) developed by the trainer. All procedures were carried out in a 25 m pool with water at 27 ± 1º C.

Training program

The macrocycle was divided into three phases and consisted of BP (high volume of training), SP (the volume starts decreasing and the intensity increases) and TP (taper). All the training sessions consisted of a warm-up period, technical training, main part and cool down. The warm-up and cool down consisted of low intensity stimuli, with a volume of 8,696 ± 3,180 $m \cdot week^{-1}$ and 2,354 ± 1,460 $m \cdot week^{-1}$, respectively. The main part of each training sessions were prescribed as proposed by Maglischo[1], with subjective intensities. The first "training zone" (End-1) consisted of low intensity (e.g., < 90% of the anaerobic threshold) and high-volume sessions, which varied between 5,000 and 8,000 m per session. The second "training zone" (End-2) was carried out at moderate intensity (e.g., 100% of the anaerobic threshold) and the volume varied between 3,500 and 5,000 m per session. The third "training zone" (End-3V), was carried out at high intensity (e.g., >110% of the anaerobic threshold) and evoked an anaerobic stimulus with a volume that ranged between 1,000 and 3,000 m per session. During BP, drills to improve technique, sessions to develop an aerobic base, stretching and aerobic training on dry land, such as running and walking, emphasizing training in End-1 were applied, totalizing 25 sessions for 5 weeks. In contrast, SP presented a reduction in volume and increased intensity. Specifically, more End-2 and End-3V sessions were carried out to increase propulsive force, totalling 32 sessions in 14 of which the athletes used parachutes for 7 weeks. The total volume in the TP varied from 2,000 to 4,000 m per day, with greater stimuli in End-1 (average of 2,500 m per week) and in End-2 (average of 1,350 m per week), with stimuli in End -3 only at the beginning of the period. TP consisted of three weeks with a main competition in the last week and only two training sessions. The sessions were characterized by coordinating exercises, swimming starts, short sprints and swimming at slow intensity. The distribution of training volume in End-1, End-2 e End-3V during the training period is represented in Figure 1.

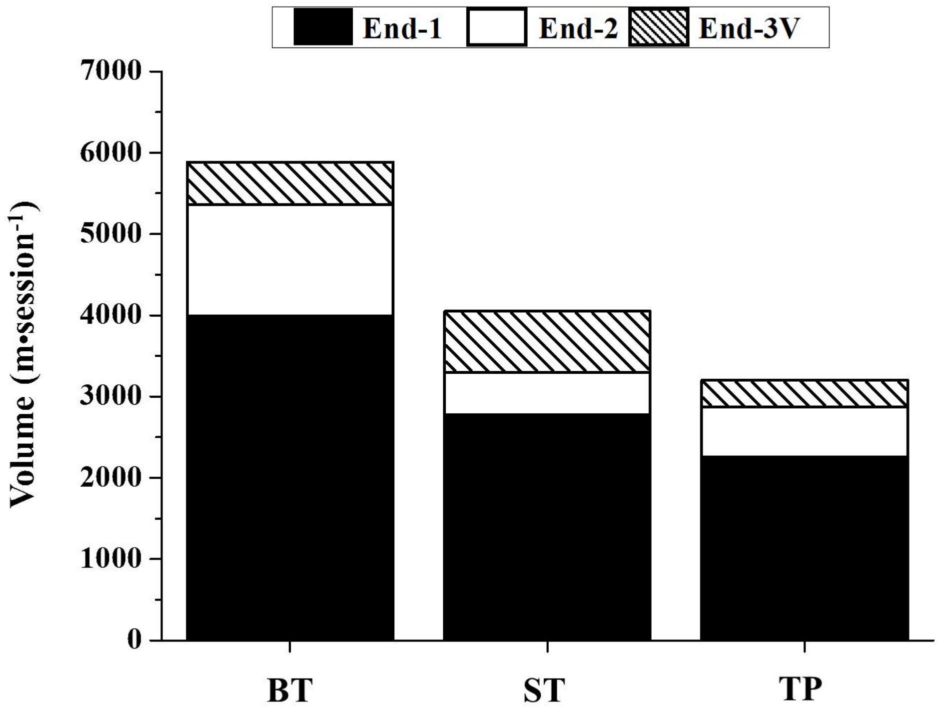

Figure 1. Volume per session during the basic period (BP), specific period (SP) and taper period (TP). End-1: sessions below the anaerobic threshold, End-2: moderate intensity at the anaerobic threshold, End-3V: high-intensity sessions prescribed above the anaerobic threshold or in maximum intensities.

Lactate minimum intensity and maximum performance

This procedure consists of two phases. Initially, hyperlactatemia was induced by a 100 m maximal performance. After eight minutes of passive recovery, the swimmers were submitted to an incremental test, consisting of five 200 m progressive efforts[20, 21]. The intensity was subjectively applied for each session, corresponding to “very light”, “light”, “moderate”, “strong” and “maximal”, as previously described[21]. Blood samples (25 µL) were collected from the ear lobe after the maximum performance (3, 5 and 7 minutes after the 100 m effort) and after each stage of the test, enabling the $[La^-]$ to be determined (2300 YSI, Yellow Springs Instruments, OH, USA).

The peak $[La\text{-}]_P$ was considered to be the highest value observed during a recovery of 8 minutes after the 100-m performance. Finally, the ratio between the intensity and $[La^-]$

during the incremental test effort was determined using a second-order polynomial adjustment, and the LMI was assumed as the lowest point of that ratio[21, 22]. All the stages were recorded at 60 fps (GoPro Hero3, Black Edition – USA) and analysed by the Kinovea software (version 8.15), Nonetheless, the swim mechanics parameters [stroke length (SL), stroke frequency (SF), and swim index (SI)] were determined in the LMI corresponding to 200 m and maximum performance.

The effort carried out as hyperlactatemia induction in the lactate minimum test was used as a performance parameter. The standard warm-up used athletes use in competitive events was applied. The beginning of this test was from the starting block.

30 secs all-out efforts in tethered swimming

To determine the force parameters in tethered swimming, the procedures were performed as described previously[23]. The athlete was connected to a 200 kg load cell (CSR-1T, MK Controle®, São Paulo - Brazil) connected to the starting block by a 6 m inextensible nylon cord. The force data were collected at 1000 Hz, through an analog-to-digital acquisition panel (NI-USB 6009, National Instruments®). For this, a Matlab® (Mathworks - r2014a, Natick MA, United States) routine was developed. The swimmers were instructed to carry a 30 secs maximum all-out effort with no specific strategy after a strong beep. Peak force (FP) was assumed to be the highest value obtained during the test, the mean force (MF) was the mean force during the entire effort, and the fatigue index (FI) was assumed to be the percentage decrease in force during the test.

Statistical analysis

The Shapiro-Wilk test confirmed the normality of the data, enabling the use of the mean and standard deviation (SD) to describe all the parameters. Moreover, the Levene test confirmed the homogeneity of variance. The two-way ANOVA analysis was used to test the differences, considering the effects of genders (male and female) and the moment of evaluations regarding the taper period (before and after the taper period). The partial ETA squared (η^2) was interpreted as small (effect size > 0.01), medium (effect size > 0.06), or large (effect size > 0.14)24. The level of significance was set at $p < 0.05$. All the analyses were conducted in SPSS version 20.0 (SPSS Inc, Chicago, IL).

RESULTS

A significant increase in volume were observed on the 14th day in TP, when the swimmers were allowed to swim as long as they felt comfortable, as long as the intensities were low. It resulted in an average of 6,000 m for that day. The total volume during the taper period is presented in Figure 2.

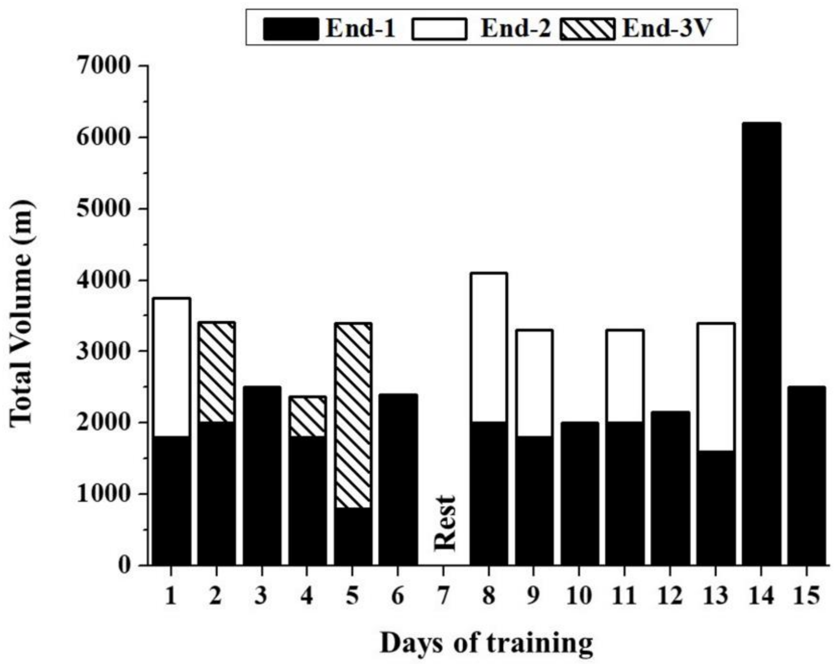

Figure 2. Behaviour of the total training volume during the 15 days of the taper period. End-1: sessions below the anaerobic threshold, End-2: moderate intensity at the anaerobic threshold, End-3V: high-intensity sessions prescribed above the anaerobic threshold or in maximal intensities.

Figure 3 presents the LMI and the mechanical parameters observed at this intensity. No taper effects were observed for LMI (p-value = 0.32; η^2 = 0.03 [small]), SL (p-value = 0.54; η^2 = 0.01 [small]), SF (p-value = 0.23; η^2 = 0.04 [small]) and SI (p-value = 0.70; η^2 = 0.004 [small]). However, all these parameters presented lower values for the women than for the men (p-value = 0.001 – 0.001; η^2 = 0.19 – 0.52 [large]). No significant interactions were observed for LMI or mechanical stroke parameters (p-value = 0.64 – 0.84; η^2 = 0.006 – 0.001 [small]).

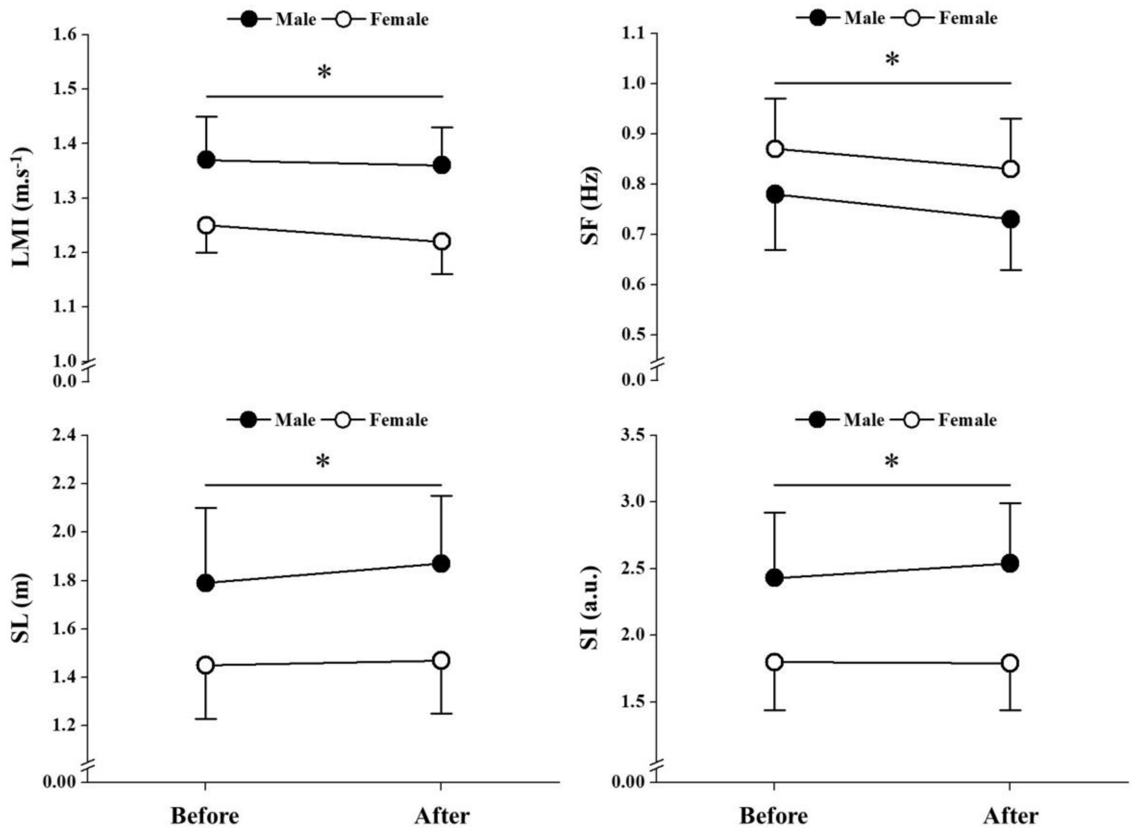

Figure 3. Lactate minimum intensity (LMI) and mechanics parameters observed in this intensity in men (closed symbols) and women (open symbols), before and after the taper period. SL: stroke length, SF: stroke frequency and SI: swim index. *Significant effects for genders ($p < 0.05$).

The performance was greater among the men (p-value = 0.001; η^2 = 0.66 [large]), but there were no effects of the TP (p-value = 0.66; η^2 = 0.006 [small]), and no significant interaction (p-value = 0.63; $\eta^2 = 0.007$ [small]) was observed. In contrast, the SF during the maximal performance was not affected by the TP (p-value = 0.21; $\eta^2 = 0.04$ [small]) or gender (p-value = 0.11; $\eta^2 = 0.07$ [medium]). Differently, significant effects of the taper period were observed for $[La^-]_P$ (p-value = 0.014; $\eta^2 = 0.16$ [large]), SL (p-value = 0.001; $\eta^2 = 0.50$ [large]) and SI (p-value = 0.04; $\eta^2 = 0.67$ [large]), with the men presenting higher values than the women (p-value < 0.05; $\eta^2 > 0.10$ [medium]). However, no interactions were observed for $[La^-]_P$ (p-value = 0.38; $\eta^2 = 0.02$ [small]). Figure 4 shows the performance and Figure 5 $[La^-]_P$ values and stroke mechanical parameters.

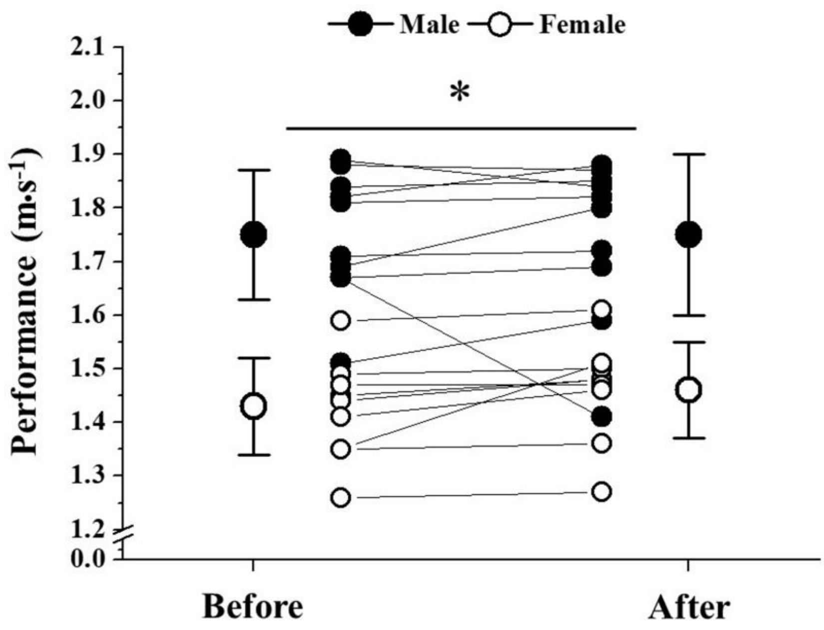

Figure 4. Individual values (symbols and lines) and means (symbols) of performance in the 100 m freestyle in men (closed symbols) and women (open symbols), before and after taper period. *Significant effects for genders (p < 0.05).

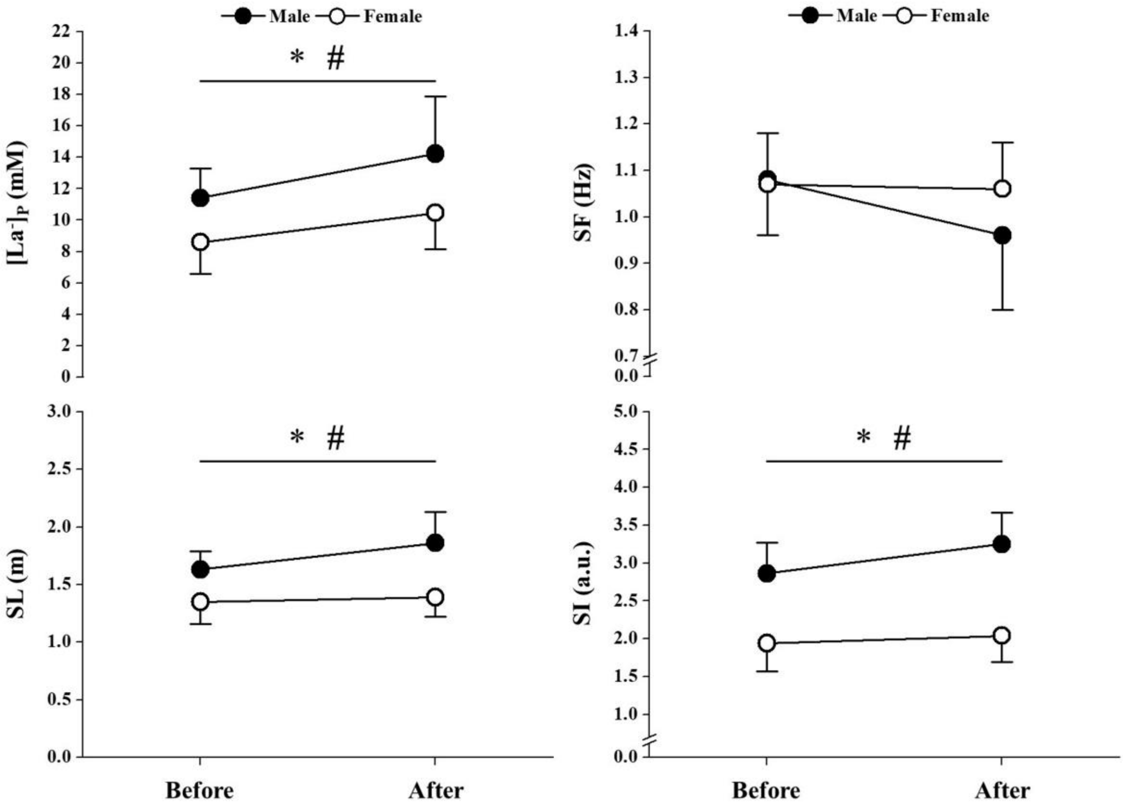

Figure 5. Concentrations of peak lactate ($[La^-]_P$) and mechanical parameters in men (closed symbols) and women (open symbols) in situations before and after taper period. SL: stroke length; SF: stroke frequency; and SI: swim index. *Significant effects for genders ($p < 0.05$). #Significant effects for the taper period ($p < 0.05$).

Figure 6 shows the effects of the TP on the 30 secs all-out effort in tethered swimming. No significant effects for the taper period were observed for PF (p-value = 0.63; η^2 = 0.006 [small]), MF (p-value = 0.67; η^2 = 0.005 [small]), or FI (p-value = 0.89; η^2 = 0.001 [small]). However, the women presented significantly lower values than the men for PF (p-value = 0.001; η^2 = 0.59 [large]) and MF (p-value = 0.001; η^2 = 0.56 [large]). No gender effects were observed for FI values (p-value = 0.90; η^2 = 0.001 [small]). No interactions were observed for 30 secs all-out efforts in tethered swimming parameters (p-value = 0.54 – 0.73; η^2 < 0.01 – 0.003 [small]).

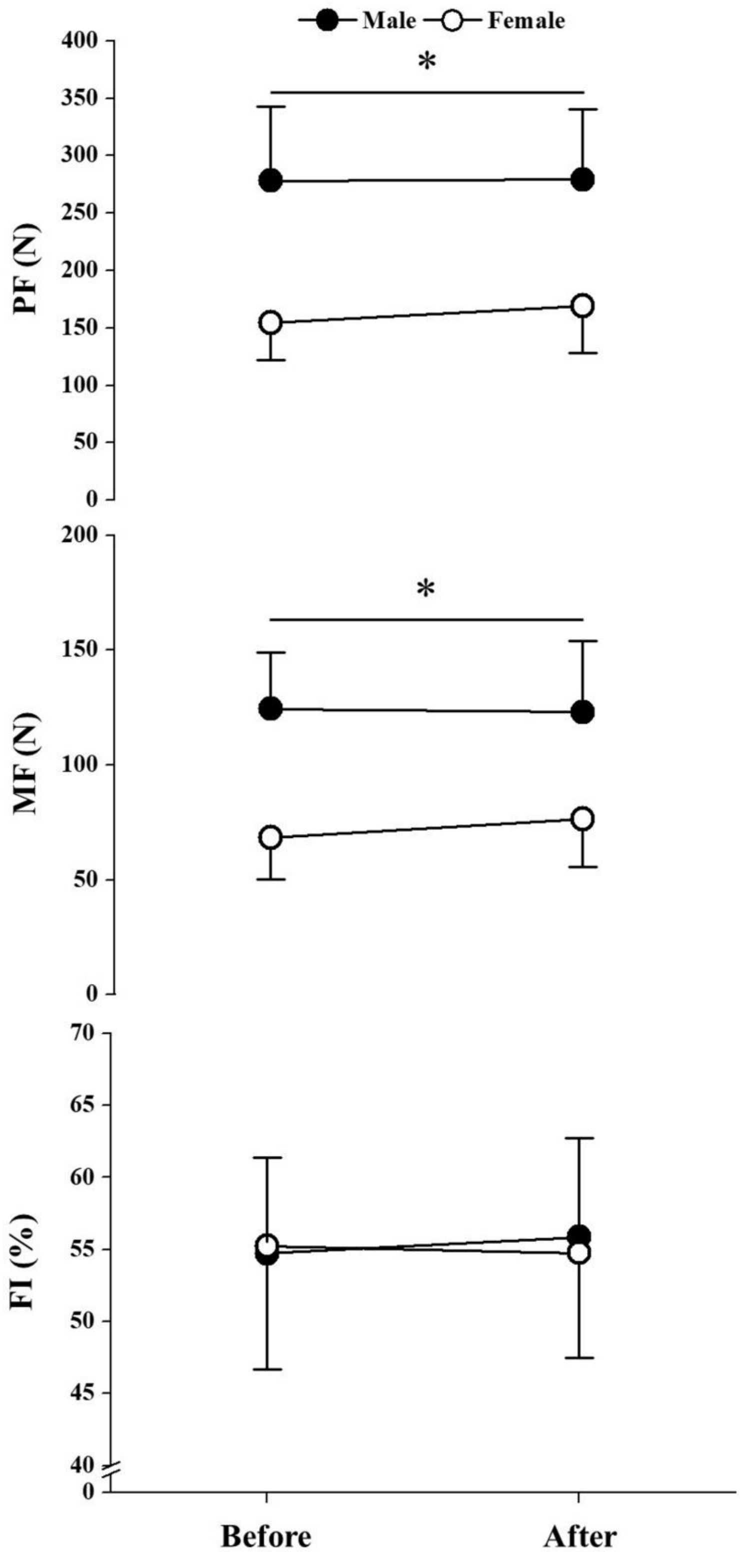

Figure 6. Values of the propulsive force parameters from the 30 seconds all-out tethered swimming effort in men (closed symbols) and women (open symbols) before and after taper period. PF: peak force, MF: mean force, FI: fatigue index. *Significant effects for genders ($p < 0.05$).

DISCUSSION

This study investigated the possible influence of the gender on the responses of swimmers during a taper period. Our results demonstrated that men and women presented the same adaptations after the TP. Moreover, despite the higher anaerobic contribution during the maximal 100 m freestyle, performance was not improved after the taper period. Moreover, no effects of the TP were observed for propulsive force and LMI (speed and mechanical parameters).

Studies that have investigated the influence of the genders on swimming have concluded that the difference between men and women in performance decreases as the distance covered increases[24]. Women stand out in resistance events as they are more economical[11] and have a greater floating capacity, enabling gliding[9], and a more developed aerobic capacity[25]. This difference may also be influenced by age[26, 27]. Differences in athletic performance appear to coincide with the onset of male puberty[26]. Female swimmers are usually faster in the period between 5 and 10 years of age and at more advanced ages, such as in the master's category[27].

Our study demonstrated greater performance, higher $[La^-]_P$ concentrations, PF, and MF among the men in relation to the women. This superiority of the men may be explained by the fact that they possess a greater capacity to endure high intensity stimuli and a more favourable anaerobic contribution, due to their greater muscle mass[13] and vaster areas occupied in the muscles by type II fibres than women[27], despite both presenting the same distribution of the muscle fibre types[10, 28]. In addition, male swimmers from 12 to 18 years of age present more considerable aerobic power, better respiratory function (greater ventilation and lower maximum respiratory rate than women) and cardiovascular function with lower maximum heart rate and blood pressure in relation to women, as well as having more haematocrits and haemoglobin[6].

Although these physiological and morphological characteristics explain the differences observed in the present study, men and women did not increase performance after the proposed taper period. Thus, Banister, Carter and Zarkadas[29] supported the importance of the taper period in the season as it can cause the improvements in performance, demonstrating that a decrease in the training volume during this period in a fast and constant way presents greater results in the performance in relation to a progressive decrease in the volume.

In light of the above mentioned, Santhiago, Da Silva[17] used a four week taper period model by decreasing the volume and maintaining the intensity after seven weeks of specific training in order to verify its influence on the haematological responses and swimmers' aerobic performance. They observed an improvement in performance in the 100 m among both sexes. However, the present study observed an undulant model of training volume, which differs from the aforementioned studies and indicates that this was not an effective strategy for this training period.

However, the $[La^-]_P$ values increased after the taper period, which can be explained by the maintenance of stimuli at high intensity with a decrease in volume during the TP, which would increase the anaerobic capacity of swimmers. This mechanism can be explained by the possible depletion of glycogen in intense efforts with high volume of training, often observed during BP and SP, which would provide overcompensation of muscle glycogen stores during the TP (i.e., volume decrease and satisfactory recovery)[30-32]. Neary, Martin[18] confirmed this hypothesis demonstrating an increase in muscle glycogen concentrations after a taper period[33]. According to Maglischo[1], determining blood lactate concentrations represent a way of evaluating anaerobic capacity and the appearance of low lactate values associated with unsatisfactory performance levels indicate a lower capacity of the lactic anaerobic system. In the present study, despite the efficiency of the program in improving the glycolytic pathway, improvements in performance were not observed, showing that success in 100 m events is not only dependent on this energy pathway.

The lactate minimum test, proposed by Tegtbur, Busse[34], stands out for its easy applicability and the lack of interference of the individual's nutritional state and the way hyperlactatemia is induced in the test[35]. Moreover, it is possible to determine the aerobic and anaerobic parameters with only one test[20, 22]. With the application of the lactate minimum test, we did not verify any difference and no significant effect on the LMI and mechanical parameters in the TP. These results may be explained by the increase in training intensity, which is related to a decrease or maintenance of the levels corresponding to the anaerobic threshold[36-38], an indication of aerobic capacity[39]. In addition, the higher $[La\text{-}]_P$ values may prove this hypothesis due to the correlation between the increase in this variable and the improvement of the lactic anaerobic system[40].

Campos, Nordsborg[21] investigated the response of the lactate minimum test in 12 weeks of swimming training and verified that the LMI is modified with the training and can be used in prescribing training and detecting alterations in anaerobic capacity during the season. They equally found no significant differences in the LMI after the taper period. In that manner, we can affirm that the TP improved anaerobic capacity and did not give rise to any effect on aerobic capacity.

Lätt, Jürimäe[41] suggested that biomechanical factors (swimming velocity, stroke rate, stroke length and stroke index) are determinant for performance in the 100 m freestyle (90.3%) and physiological parameters represented only 45.2% of performance. Silva, Figueiredo[42] found that mechanical parameters are different between genders in sprint events, where male swimmers performed better as they possess higher values of SF and SI. The present study presented a sensitivity of the mechanical parameters on the performance (SL e SI) to the TP and the difference between genders, but these responses were not transferred to performance. The increase in the volume over the sessions with coordinating exercises may have influenced these parameters through improving swimming technique, but they were not determining for improving performance. Considering that the increase in swimming speed is determined by the swimmer's ability to override the hydrodynamic resistance[40, 43], together our results indicate that although the TP was effective for improving the technique, when these adaptations are not accompanied by increased propulsive strength (e.g., parameters of 30 secs all-out tethered swimming), the performance presents trivial changes.

The alterations derived from the TP may be more related to the force and power[28, 44], but the increase in these variables is not always accompanied by improving performance[45]. Papoti, Martins[46] verified the effect of an experimental taper period on the tied swimming force and the 200 m performance of swimmers after 10 weeks of training and, unlike our findings, noted an increase in these variables after an 11-day taper period. In addition, Havriluk[47] verified a reduction in MF, measured by manual pressure, during a maximum 10 m effort during a competitive season. This author suggests that if the reduction in force is between 10 and 20% in relation to the baseline, the swimmer can recover and increase force after the taper period. In this context, the decrease in strength induced by the ST applied in the present study may have been greater than the recovery capacity promoted by the TP, explaining the trivial changes observed for PF and MF. However, we can only speculate this relationship between the state of fatigue and recovery, since the strength parameters were not quantified in all phases of training applied in this study.

This study advances the knowledge on different taper periods, focusing on the possible differences between genders, which will help to plan this phase of training. However, some limitations should be considered. Despite monitoring the stimuli used during the basic and specific period, it was not possible to determine performance, LMI, and force parameters in each phase of the training, impeding inferences about the behaviour of these variables over the entire periodization. Another limitation is the lack of internal load monitoring. These data would enable us to better understand, for instance, the state of training at which the participants find themselves during the period and if the stimuli are adequate for the possible gains and responses expected after the taper period. In spite of that, it is possible that the performance in the 100 m freestyle was underestimated, mainly because it was also used to induce hyperlactacidemia during the minimum lactate protocol. However, considering the high values of the $[La^-]_P$, we cannot assume the swimmers did not perform the faster 100 m possible. Although we have not monitored the menstrual cycle of the female participants, studies have shown that this parameter does not interfere with variables related to aerobic capacity[48] and muscle strength[49, 50].

Although the physiological differences between genders, the present study allows us understand that independent of stimuli during the taper period both obtained the similar adaptations. These findings provide us a better understanding the behavior of variables observed after the taper period typical of swimming. Area professionals can benefit this model for prescription and planning of the effective training for both men and women, emphasizing an individual prescription. Still, this model training and taper did not correspond and it was not a sufficient stimulus that increased performance in 100-m freestyle, increased $[La^-]_P$ allows us used this micro cycle in others moments of the program whit the aim of developing lactate production and not exactly in the taper period.

For us knowledge the taper period is determinant for competitive success. However, more research should be motivated for better comprehension between genders differences, physiological responses and mechanical throughout the training program and on the different load distribution models in addition to the volume-intensity relationship in each planning period.

CONCLUSIONS

In conclusion, although the $[La^-]_P$ values increased after the proposed TP these responses were not transferred to the 100 m performance, as well aerobic capacity, accessed via the LMI, and the propulsive force parameters, were also not altered. Despite the men and women presenting significantly different values in the age group studied, the responses observed after the TP investigated were the same independent of gender. We can say that even men presenting higher values than women in relation to the variables studied, the behavior of responses in relation to TP are the same for both.

REFERENCES

1. Maglischo EW. Nadando o mais rápido possível: Manole; 2010.
2. Pugliese L, Porcelli S, Bonato M, Pavei G, La Torre A, Maggioni MA, et al. Effects of manipulating volume and intensity training in masters swimmers. International journal of sports physiology and performance. 2015;10(7):907-12.
3. Mujika I, Busso T, Lacoste L, Barale F, Geyssant A, Chatard J-C. Modeled responses to training and taper in competitive swimmers. Medicine and science in sports and exercise. 1996;28(2):251-8.
4. Thomas L, Mujika I, Busso T. A model study of optimal training reduction during pre-event taper in elite swimmers. Journal of sports sciences. 2008;26(6):643-52.
5. Laursen PB. Training for intense exercise performance: high-intensity or high-volume training? Scandinavian journal of medicine & science in sports. 2010;20:1-10.
6. Wells GD, Schneiderman-Walker J, Plyley M. Normal physiological characteristics of elite swimmers. Pediatric Exercise Science. 2006;18(1):30-52.
7. Holfelder B, Brown N, Bubeck D. The influence of sex, stroke and distance on the lactate characteristics in high performance swimming. PloS one. 2013;8(10):e77185.
8. Knechtle B, Dalamitros AA, Barbosa TM, Sousa CV, Rosemann T, Nikolaidis PT. Sex Differences in Swimming Disciplines—Can Women Outperform Men in Swimming? International Journal of Environmental Research and Public Health. 2020;17(10):3651.

9. Onodera S. Effect of buoyancy and body density on energy cost during swimming. Biomechanics and Medicine in swimmingVIII. 1999;8:355-8.
10. Caspersen C, Berthelsen PA, Eik M, Pâkozdi C, Kjendlie P-L. Added mass in human swimmers: age and gender differences. Journal of Biomechanics. 2010;43(12):2369-73.
11. Barbosa TM, Fernandes R, Keskinen K, Vilas-Boas J. The influence of stroke mechanics into energy cost of elite swimmers. European journal of applied physiology. 2008;103(2):139-49.
12. Barbosa T, Costa M, Morais J, Moreira M, Silva A, Marinho D. How informative are the vertical buoyancy and the prone gliding tests to assess young swimmers' hydrostatic and hydrodynamic profiles? Journal of Human Kinetics. 2012;32(1):21-32.
13. Crewther B, Cronin J, Keogh J. Possible stimuli for strength and power adaptation: acute metabolic responses. Sports Medicine. 2006;36(1):65-79.
14. Southren AL, Gordon GG, Tochimoto S, PINZON G, Lane DR, Stypulkowski W. Mean plasma concentration, metabolic clearance and basal plasma production rates of testosterone in normal young men and women using a constant infusion procedure: effect of time of day and plasma concentration on the metabolic clearance rate of testosterone. The Journal of Clinical Endocrinology & Metabolism. 1967;27(5):686-94.
15. Torjesen PA, Sandnes L. Serum testosterone in women as measured by an automated immunoassay and a RIA. Clinical chemistry. 2004;50(3):678-.
16. Santhiago V, Da Silva AS, Papoti M, Gobatto CA. Responses of hematological parameters and aerobic performance of elite men and women swimmers during a 14-week training program. The Journal of Strength & Conditioning Research. 2009;23(4):1097-105.
17. Santhiago V, Da Silva AS, Papoti M, Gobatto CA. Effects of 14-week swimming training program on the psychological, hormonal, and physiological parameters of elite women athletes. The Journal of Strength & Conditioning Research. 2011;25(3):825-32.
18. Neary J, Martin T, Reid D, Burnham R, Quinney H. The effects of a reduced exercise duration taper programme on performance and muscle enzymes of endurance cyclists. European journal of applied physiology and occupational physiology. 1992;65(1):30-6.
19. FINA. Féderátion Internationale de Natation. Switzerland: Available from: http://www.fina.org/fina-rankings/filter/records; 2018-2020 [2020 Set 30].
20. Ribeiro LFP, Gonçalves CGS, Kater DP, Lima MCS, Gobatto CA. Influence of recovery manipulation after hyperlactemia induction on the lactate minimum intensity. European journal of applied physiology. 2009;105(2):159-65.
21. Campos EZ, Nordsborg NB, Silva ASRd, Zagatto AM, Gerosa Neto J, Andrade VLd, et al. The response of the lactate minimum test to a 12-week swimming training. Motriz: Revista de Educação Física. 2014;20(3):286-91.
22. Pardono E, da Costa Sotero R, Hiyane W, Mota MR, Campbell CSG, Nakamura FY, et al. Maximal lactate steady-state prediction through quadratic modeling of selected stages of the lactate minimum test. The Journal of Strength & Conditioning Research. 2008;22(4):1073-80.
23. Papoti M, Martins L, Cunha S, Zagatto A, Gobatto C. Padronização de um protocolo específico para determinação da aptidão anaeróbia de nadadores utilizando células de carga. Revista Portuguesa de Ciências do Desporto. 2003;3(3):36-42.
24. Wild S, Rüst CA, Rosemann T, Knechtle B. Changes in sex difference in swimming speed in finalists at FINA World Championships and the Olympic Games from 1992 to 2013. BMC Sports Science, Medicine and Rehabilitation. 2014;6(1):25.

25. Stanula A, Maszczyk A, Roczniok R, Pietraszewski P, Ostrowski A, Zając A, et al. The development and prediction of athletic performance in freestyle swimming. Journal of Human Kinetics. 2012;32(2012):97-107.
26. Handelsman DJ. Sex differences in athletic performance emerge coinciding with the onset of male puberty. Clinical endocrinology. 2017;87(1):68-72.
27. Senefeld JW, Clayburn AJ, Baker SE, Carter RE, Johnson PW, Joyner MJ. Sex differences in youth elite swimming. PloS one. 2019;14(11):e0225724.
28. Trappe S, Costill D, Thomas R. Effect of swim taper on whole muscle and single muscle fiber contractile properties. Medicine and science in sports and exercise. 2000;32(12):48-56.
29. Banister EW, Carter J, Zarkadas P. Training theory and taper: validation in triathlon athletes. European journal of applied physiology and occupational physiology. 1999;79(2):182-91.
30. Costill D, Hinrichs D, Fink W, Hoopes D. Muscle glycogen depletion during swimming interval training. J Swim Res. 1988;4:15-8.
31. Costill DL, Flynn MG, Kirwan JP, Houmard JA, Mitchell JB, Thomas R, et al. Effects of repeated days of intensified training on muscle glycogen and swimming performance. Med Sci Sports Exerc. 1988;20(3):249-54.
32. Hermansen L, Hultman E, Saltin B. Muscle glycogen during prolonged severe exercise. Acta Physiologica Scandinavica. 1967;71(2-3):129-39.
33. Shepley B, MacDougall JD, Cipriano N, Sutton JR, Tarnopolsky MA, Coates G. Physiological effects of tapering in highly trained athletes. Journal of Applied Physiology. 1992;72(2):706-11.
34. Tegtbur U, Busse MW, Braumann KM. Estimation of an individual equilibrium between lactate production and catabolism during exercise. Medicine and science in sports and exercise. 1993;25(5):620-7.
35. Johnson M, Sharpe G. Effects of protocol design on lactate minimum power. International journal of sports medicine. 2011;32(03):199-204.
36. Costa MJ, Bragada JA, Mejias JE, Louro H, Marinho DA, Silva AJ, et al. Tracking the performance, energetics and biomechanics of international versus national level swimmers during a competitive season. European journal of applied physiology. 2012;112(3):811-20.
37. Mujika I, Padilla S. Detraining: loss of training-induced physiological and performance adaptations. Part I. Sports Medicine. 2000;30(2):79-87.
38. Mujika I, Padilla S. Detraining: loss of training-induced physiological and performance adaptations. Part II. Sports Medicine. 2000;30(3):145-54.
39. Di Prampero P, Atchou G, Brückner J-C, Moia C. The energetics of endurance running. European journal of applied physiology and occupational physiology. 1986;55(3):259-66.
40. Zamparo P, Capelli C, Cautero M, Di Nino A. Energy cost of front-crawl swimming at supra-maximal speeds and underwater torque in young swimmers. European journal of applied physiology. 2000;83(6):487-91.
41. Lätt E, Jürimäe J, Mäestu J, Purge P, Rämson R, Haljaste K, et al. Physiological, biomechanical and anthropometrical predictors of sprint swimming performance in adolescent swimmers. Journal of sports science & medicine. 2010;9(3):398.
42. Silva AF, Figueiredo P, Ribeiro J, Alves F, Vilas-Boas JP, Seifert L, et al. Integrated Analysis of Young Swimmers' Sprint Performance. Motor control. 2019;23(3).
43. Zamparo P, Cortesi M, Gatta G. The energy cost of swimming and its determinants. European Journal of Applied Physiology. 2020;120(1):41-66.

44. Sharp RL, Troup JP. Relationship between power and sprint freestyle. Med Sci Sports Exerc. 1982;14:53-6.
45. Hooper SL, Mackinnon LT, Ginn EM. Effects of three tapering techniques on the performance, forces and psychometric measures of competitive swimmers. European journal of applied physiology and occupational physiology. 1998;78(3):258-63.
46. Papoti M, Martins LE, Cunha SA, Zagatto AM, Gobatto CA. Effects of taper on swimming force and swimmer performance after an experimental ten-week training program. The Journal of Strength & Conditioning Research. 2007;21(2):538-42.
47. Havriluk R. Seasonal variations in swimming force and training adaptation. Journal of Swimming Research. 2013;21(1).
48. Smekal G, Von Duvillard SP, Frigo P, Tegelhofer T, Pokan R, Hofmann P, et al. Menstrual cycle: no effect on exercise cardiorespiratory variables or blood lactate concentration. Medicine & Science in Sports & Exercise. 2007;39(7):1098-106.
49. ELLIOTT KJ, CABLE NT, REILLY T, DIVER MJ. Effect of menstrual cycle phase on the concentration of bioavailable 17-β oestradiol and testosterone and muscle strength. Clinical Science. 2003;105(6):663-9.
50. Romero-Moraleda B, Coso JD, Gutiérrez-Hellín J, Ruiz-Moreno C, Grgic J, Lara B. The Influence of the Menstrual Cycle on Muscle Strength and Power Performance. Journal of Human Kinetics. 2019 21 Aug. 2019;68(1):123. English.

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