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Original

Effect of duration of tapering on 100-m freestyle performance in swimmers

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ABSTRACT

Objective: The aim of this study was to analyze the effect of tapering duration on 100-m freestyle performance in swimmers.
Method: This is an experimental research with 16 weeks' duration. Participants were 37 male swimmers aged between 15 and 17 years. The 100-m freestyle performance was evaluated before of the season start (pre-experiment), at the end of last week of each mesocycle (Preparatory, Specific I and Specific II) and the end of each week in the tapering phase. The performance was evaluated from the simulation of the 100-m freestyle race.
Results: It was identified time effect for the 100-m freestyle performance (p < 0.001).
Conclusion: It was concluded that two weeks of tapering were enough for the enhancement of 100-m freestyle performance.
Keywords: Athletes; Athletic Performance; Sports; Swimming.

Efecto de la duración del tapering sobre el rendimiento en los 100 metros estilo libre en nadadores

RESUMEN

Objetivo: El objetivo de este estudio fue analizar el efecto de la duración del *tapering* sobre el rendimiento en los 100 metros estilo libre en nadadores.
Método: Se trata de una investigación experimental con una duración de 16 semanas. Los participantes fueron seleccionados de forma no probabilística, totalizando 37 voluntarios del sexo masculino con edades entre 15 y 17 años. El rendimiento en los 100 metros estilo libre fue evaluado antes del inicio de la temporada, al final de la última semana de cada mesociclo (Preparatorio I, Específico I y Específico II) y al final de cada semana en la fase de *tapering*. El rendimiento de los jóvenes nadadores fue evaluado a partir de la simulación de la prueba de 100 metros estilo libre.
Resultados: Fue identificado un efecto de tiempo (*p* < 0.001) para el rendimiento en los 100 metros estilo libre.
Conclusión: Se concluye que dos semanas de *tapering* fueron suficientes para la potencialización del rendimiento en los 100 metros estilo libre.
Palabras clave: Atletas; Rendimiento Atlético; Deporte; Natación.

Efeito da duração do polimento sobre o desempenho nos 100m livre em nadadores

RESUMO

Objetivo: O objetivo deste estudo foi analisar o efeito da duração do polimento sobre o desempenho nos 100 m livre em nadadores.
Método: Trata-se de uma investigação experimental com duração de 16 semanas. Os participantes foram selecionados de forma não probabilística, totalizando 37 voluntários do sexo masculino com idade entre 15 e 17 anos. O desempenho nos 100 m livre foi avaliado antes do início da temporada (pré-experimento), ao final da última semana de cada mesociclo (Preparatório I, Específico I e Específico II) e ao final de cada semana na fase do polimento. O desempenho dos jovens nadadores foi avaliado a partir da simulação da prova de 100 m livre.
Resultados: Foi identificado efeito de tempo (*p* < 0.001) para o desempenho nos 100 m livre.
Conclusão: Concluiu-se que duas semanas de polimento foram suficientes para a potencialização do desempenho nos 100 m livre em jovens atletas de natação.
Palavras chave: Atletas; Desempenho Atlético; Esporte; Natação

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Introduction

Swimming is an individual aquatic sport with the predominance of the use of anaerobic metabolism in most of its races.[1] However, in the case of young athletes in swimming, considering the time under physical exertion in races, it seems that the aerobic metabolism can also exert considerable energy contribution[1]. The competitive swimming program includes tests ranging from distance (50 m to 1.500 m) and swimming style (crawl, butterfly, backstroke, breakstroke or medley).[2] The 100-m freestyle performance race depends on innumerable variables, namely: genetics, metabolism, swimming technique, body composition and/or psychological capacity.[3] Thus, the improvement in any one of these variables can lead to improve the 100-m freestyle performance.

The use of specific methods of physical/technical training and periodization are some of the strategies that can be adopted for increase of the performance of athletes.[4] According to Loturco and Nakamura,[5] periodization involves the manipulation of training loads, means and training methods in specific periods with well-defined objectives. At the end of the periodization, it seems to be common the use of the tapering strategy in swimming athletes.[6,7]

The tapering is indicated as a periodization prescription technique that has the premise of reducing the training load (specifically the volume) of all components of the training sessions, although the intensity is maintained.[8,9] Studies have shown positive effects of tapering on performance of athletes.[6,10-12] Le Meur et al.[9] stress that the use of the tapering strategy at the end of the competitive season may reduce the levels of muscle damage markers, increase serum anabolic hormone levels, increase enzyme activity and of the rate of recruitment of rapidly contracting muscle fibers.

Although there is scientific evidence regarding the effect of tapering on athlete performance,[6,10-13] there is still no consensus regarding the duration of tapering to achieve peak sports performance. On the one hand, studies have shown that one to two weeks of tapering is the time required to optimize the performance of athletes.[10-12] On the other hand, studies indicated three to four weeks of tapering for athletes to achieve the best performance of the competitive season.[6,13]

From the information above, the objective of this study was to analyze the effect of tapering duration on the 100-m freestyle performance in swimmers. The hypothesis is that two weeks of tapering will be sufficient to optimize the 100-m freestyle performance in swimmers.

Method

Experimental design

This is an experimental investigation lasting 16 weeks. The description of the training can be observed in Figure 1. Aerobic training was developed in three zones of intensity: aerobic one (below the anaerobic threshold), aerobic 2 (in anaerobic threshold) and aerobic 3 (maximum aerobic power). The anaerobic training was conducted in three zones of intensity: speed 1 (lactate tolerance), speed 2 (maximum lactate production) and speed 3 (anaerobic power).

The undulating periodization with weekly variation of the training load was adopted.[14] The initial focus on tapering phase was four weeks, adopting the linear tapering method.[9] Thus, only training volume was reduced: 85% for the first, 70% for the second, 55% for the third and 40% in the fourth week, following Mujika, Chaouachi and Chamari's indications.[7]

The 100-m freestyle performance was evaluated before the beginning of the season, at the end of the last week of each mesocycle and at the end of each week in the tapering phase, totaling 8 evaluations. It was also noted that the lactate threshold

test was conducted every 4 weeks to adjusting the participants' aerobic training intensity.
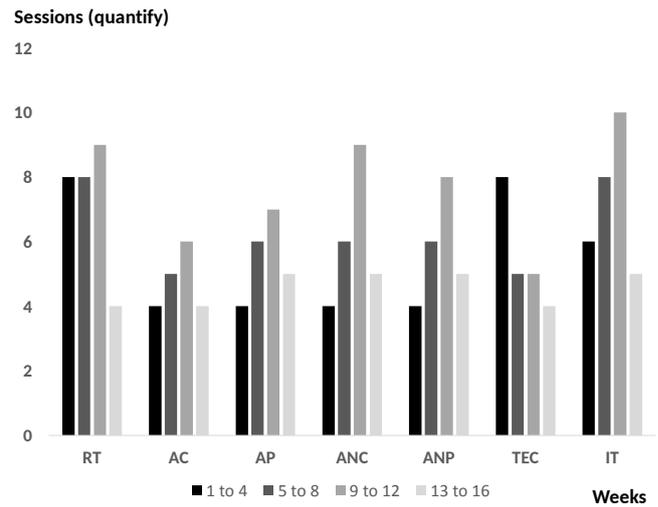

Figure 1. Description of training mesocycles of young swimming athlete. RT: Resistance Training; AC: Aerobic Capacity (aerobic 1 or 2); AP: Aerobic Power (aerobic 3); ANC: Anaerobic Capacity (speed 1 or 2); ANP: Anaerobic Power (speed 3); TEC: Swim Technical; IT: Imagery Training.

Sample

Participants were 42 male swimmers aged from 15 to 17 years, freestyle swimming specialists. However, 5 volunteers were excluded because they lacked more than 5% of the training sessions during the investigation. Therefore, the study had a final sample of 37 volunteers (age = 15.72 ± 1.46 years, training regimen = 10.03 ± 0.13 hours per week, body fat percentage = 18.32 ± 5.30%, biological maturation = 2.45 ± 1.18 years passed from the peak rate of growth in height). The selected sample size provided a statistical power > 95%.

After receiving information on the procedures to which they would be submitted, the participants signed a consent form and their parents signed the informed consent form. The procedures adopted in this study complied with the Helsinki Declaration, after approval of the research ethics committee of the Federal University of Pernambuco, Brazil.

Procedures

The performance of the young swimmers was evaluated from the simulation of the 100-m freestyle race. Electronic boards (Daktronics®, Brazil) were used to gauge swimmers' time. It was performed 5 min warm-up with sprints of 10 m each min. Next, a rest interval of 10 min was conceived before the start of the simulation of the 100-m freestyle race in function of the potential post-activation phenomenon.[15] It should be noted that all athletes were familiar with the 100-m freestyle race. The time was used in seconds to determine the performance.

The internal training load was quantified by adopting the daily mean of the Rated Perceived Exertion (RPE) session method (RPE-session).[16] After 30 minutes of the end of each training session the athletes answered the following question: "How was your training?". The athlete was asked to demonstrate the intensity perception of the session from the 11-point Borg scale (0 = rest at 10 = maximum effort), according to the method developed by Foster et al.[16] The product of the values demonstrated by the RPE scale and the duration in minutes of each session was calculated, thus expressing the internal load of the training session. The weekly internal training load was obtained from the sum of the daily loads and divided by five. The internal load of each

mesocycle was calculated from the sum of the respective weekly internal loads and divided by four (quantity of micro cycles per mesocycle). It is emphasized that the athletes were familiar with the RPE-session method for a period of fifteen days before the beginning of the investigation. The internal load of each micro cycle can be visualized in Figure 2.
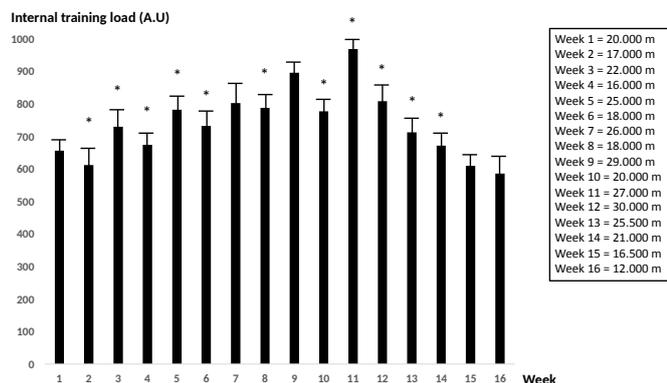

Figure 2. Internal training load (Rated Perceived Exertion-session method) weekly according to micro cycle. *p<0.05 in relation to after micro cycle; A.U = arbitrary units.

Adaptation of the protocol proposed by Tegtbur, Busse and Brauman[17] was used to determine the speed equivalent to the lactate threshold. The athletes made two maximum efforts of 50 m in the crawl style with interval of 1 min between them, to induce a considerable accumulation of lactate in the bloodstream (lactic acidosis). Then, after a passive recovery period of 8 min, the volunteers started an incremental exercise protocol with stages of 200 m, initial velocity between 1.05 and 1.25 $m·s^{-1}$ and increments of 0.05 $m·s^{-1}$ at each repetition until exhaustion. The initial velocity was chosen by each athlete so that four to six efforts were performed. At the seventh minute after induction of lactic acidosis and immediately after each repetition during the incremental phase blood samples were collected from the swimmers for the determination of lactate concentration. The velocity equivalent to the lactate threshold was the one in which the lowest blood lactate concentration was observed during the progressive phase of the test. Lactate analysis were performed from samples of 25 μl of blood collected from the ear lobe of the swimmers, without hyperemia, in heparinized capillary. These samples were immediately transferred to 1.5 ml eppendorf tubes containing 50 μl of 1% NaF solution and stored on ice for further electro-enzymatic reading (YSL 2700 STAT, Yellow Springs Co., USA).

Biological maturation was evaluated through somatic maturation. Thus, body mass, height and trunk-cephalic height were measured. The lower limb length was obtained by the difference between height and trunk-cephalic height. These measures, along with a chronological age were used in an equation established by Mirwald et al.,[18] which estimates the peak age of growth rate in height.

A portable digital scale (Tanita® BC-601 model, São Paulo, Brazil) and a portable stadiometer (Welmy®, Santa Bárbara do Oeste, Brazil) were used to determine body mass and height. The triceps, pectoral and subscapular skinfold thicknesses were measured by a Lange (Lange©, Washington, USA) adipometer for body density estimation using the predictive equation.[19] Relative body fat was estimated by the Siri equation.[20] The skinfold thicknesses were measured three times at the same location, with rotational management, adopting the average of the values.

Data analysis

The Shapiro-Wilk test was conducted to evaluate the distribution of the data. Measures of central tendency and dispersion were used to describe the variables of the investigation. Variance analysis of repeated measurements was used to compare the 100-m freestyle performance according to competitive season phase. The Bonferroni post hoc test was used to locate statistical differences. The peak age of growth rate in height was statistically controlled (covariate). The calculation of the effect size was adopted for the analysis of the magnitude of the differences (d <0.2 = trivial, 0.2 ≤ d <0.4 = low effect size, 0.4 ≤ d> 0.8 = moderate effect e, d ≥ 0.8 = large effect size).[21] All data were processed in the SPSS 21.0 software, adopting a significance level of 5%.

Results

Figure 3 presents the results of the comparisons of 100 m freestyle performance according to season phase. It was identified time effect (p <0.001) on 100 m freestyle performance, with increase of pre-experiment for preparatory phase I (p = 0.01, effect size = 0.6), maintenance until the specific II phase (p > 0.05), increase in first (p = 0.01, effect size = 0.8) and second weeks of the tapering phase (p = 0.01, effect size = 0.7), maintenance in third (p > 0.05), finishing with attenuation in fourth week of tapering (p = 0.01; effect size = 0.9).

The results showed collinearity (data from the statistical control adopted at variance analysis of repeated measurements) of the peak age of growth rate in height with the 100-m freestyle performance ($F_{(1, 36)}$ = 43.04, p = 0.01).
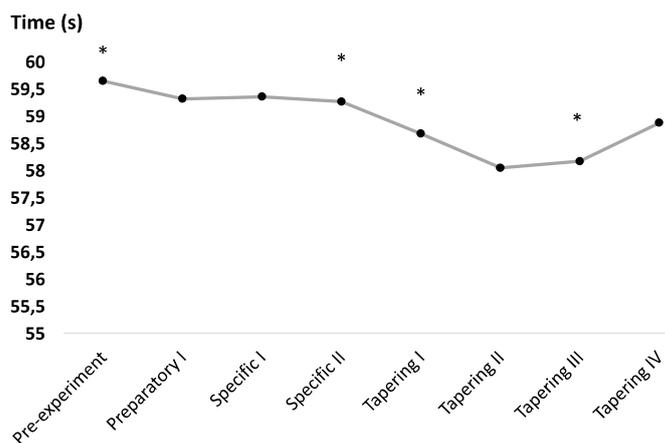
	Minimum (s)	Maximum (s)
Pre-experiment	57.62	61.37
Preparatory I	56.80	61.05
Specific I	56.93	61.49
Specific II	56.70	61.13
Tapering I	56.31	60.82
Tapering II	56.02	60.93
Tapering III	55.87	60.24
Tapering IV	56.29	60.41

Δ% = 2.4%
ES = 0.9
F = 61.8
p = 0.001

Figure 3. Mean and standard deviation of 100-m freestyle performance according to investigation step (pre-experiment, preparatory I, specific I, specific II, tapering I, II, III and IV). ES = effect size; *p < 0.05 in relation after micro cycle; Δ% (percentage variation) = 100-m freestyle performance variation.

Discussion

The present investigation had as premise to analyze the effect of the duration of the tapering on the 100-m freestyle performance in swimmers. The results showed peak performance after the second and third tapering weeks.

It is reasonable to report that the internal training load significantly reduced during the tapering phase. Soon, whereas the internal training load has close relation with sports performance,[2,3] it is possible to assume that the improvement of the 100-m freestyle performance occurred due to the reduction of internal training load. It seems that the reduction of internal training load favors the recovery of athletes.[2] Once the optimized recovery, commonly occurs to enhance sports performance. According to the scientific literature,[6,11-12] the tapering strategy is considered fundamental to enhance the performance of athletes. According to Mujika, Chaouachi and Chamari,[7] levels of muscle damage markers (creatine kinase and lactate dehydrogenase) decrease, just as serum levels of anabolic hormones (growth hormone and testosterone) increase after a few weeks of tapering. In addition, scientific research has shown that enzymatic activity and recruitment velocity of rapidly contracting muscle fibers increased after two weeks of tapering in high-level athletes.[7] However, little is known about the required length of the tapering period to enhance the performance of athletes.

Studies revealed that one to two weeks of tapering is the time required to optimize the performance of athletes.[10-12] On the other hand, research showed to the need for more time (three to four weeks) of tapering for athletes to reach the peak of sport performance.[6,13] The findings of the present investigation identified that two to three weeks were enough to improve on 100-m freestyle performance. Therefore, it seems that a week, as well as four weeks adopting the tapering strategy may not be the best duration for young swimming athletes.

Perhaps only a week of reducing the volume of training of young swimming athletes is ineffective to greatly reduce muscle damage from training and/or potentiate the speed of recruitment of fast-twitch muscle fibers. Another explanation may be the low volume reduction (85% of the total volume) between the last micro cycle of the "specific II" period and the first week of the tapering. The attenuation of only 15% of training volume may not be sufficient to induce positive neurophysiological adaptations in young swimming athletes. Perhaps a reduction of more than 15% of the volume of training as early as the first week of taper can be a good strategy to enhance the performance of young swimmers when the taper period is reduced. In contrast, four weeks of tapering can be considered excessive time to maintain or improve the 100-m freestyle performance. Wiewelhove et al.[22] revealed that some consecutive weeks of progressive reduction of training load resulted in attenuation of the contractile properties of athlete's muscle fibers. Mujika, Chaouachi and Chamari[7] showed that a few weeks of low volume of high intensity training may cause the performance of athletes to be reduced due to the loss of physiological adaptations (acceleration of metabolic reaction enzymes).

Concerning the peak of growth velocity in height, the findings of the present study demonstrated an effect on 100 m freestyle performance, corroborating other investigation.[10] The maturational process results in growth and development of the muscular system,[18] which may explain the better physical and sports performance in biologically mature athletes.

Although the experimental design of the present investigation is unheard with young swimming athletes, it is necessary to mention some limitations. Blood lactate production was not evaluated after the 100-m freestyle test simulation. In addition, the nutritional diet of young athletes was not controlled. Besides, it has not been possible to include control group in experimental design. Therefore, the results should be treated with caution.

It was concluded that two weeks of tapering were sufficient for the potentiation of 100-m freestyle performance in young male swimmers. This study demonstrated that the gradual reduction of training volume over two weeks may be an efficient strategy to enhance the performance of young swimmers.

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