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Salivary steroids hormones, well-being, and physical performance during an intensification training period followed by a tapering period in youth rhythmic gymnasts

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ABSTRACT

This study examined the effect of an intensification period (IT; 4 weeks; after a habitual training period; HT) followed by a tapering period (TP; 2 weeks) on salivary hormones (testosterone - T and cortisol - C), well-being (WB), and physical performance in 23 rhythmic gymnasts (RG; Under-11 group [G1], Under-13 group [G2], and > 13 group [G3]). The session-rating of perceived exertion was used to quantify the daily internal training load (ITL). The WB questionnaire was completed daily. Physical performance tests and saliva sampling were carried out at the beginning of the IT (T1), after IT (T2), and after TP (T3). A higher ITL was observed for IT compared to HT (2310 ± 327 vs 2940 ± 334, 2449 ± 237 vs 3902 ± 273, 2278 ± 436 vs 3954 ± 866 arbitrary units [UA], for G1, G2, and G3, respectively) and TP (vs 1781 ± 260, 2305 ± 298, 2415 ± 522 AU). No significant change was detected for T concentration (206 ± 39, 221 ± 35, 216 ± 51 ρmol/L, for T1, T2, and T3, respectively [whole group]; $p = 0.16$), C concentration (5.7 ± 1.0, 5.8 ± 0.8, 5.0 ± 0.7 nmol/L; $p = 0.07$), and WB (19 ± 3, 19 ± 2, 19 ± 2; $p = 0.44$). A significant lower WB score was observed for the G3. Physical performance increased for sit-ups from T2 to T3 (ES = 0.80), and T1 to T3 (ES = 0.78) and for push-ups (T2-T3; ES = 0.61; T1-T3; ES = 0.55). In summary, a period of IT followed by TP, seems to be a useful approach to improve physical performance of youth RG, while maintaining the perception of WB and the hormonal milieu.

1. Introduction

A popular periodization approach involves intensification of training load periods (IT) followed by tapering periods (TP) [1,2]. Previous studies have shown that this strategy may improve physical fitness and performance in team sports [3,4] and individual sports [5,6]. Indeed, this periodization strategy has been also examined in youth athletes, including basketball players [7,8], tennis players [9], and soccer players [10]. For example, Miloski et al. [7] reported that a 4-week IT followed by a 3-week TP successfully improved physical performance (endurance and agility) of young basketball players. Moreover, Freitas et al. [10] examined the effect of a 2-week IT phase followed by a 2-week TP in elite youth male soccer players on salivary cortisol (C) concentration, stress tolerance, and severity of upper respiratory tract infection (URTI) symptoms. These researchers reported that the IT led to a higher C concentration in comparison with TP, and that the observed decrease in salivary C level during TP indicates an adaptive response of the hypothalamic-pituitary-adrenal (HPA) axis to the reduction in training volume. However, there was no difference in URTI symptoms and stress tolerance between training phases. Taking into account these results, the authors suggested that salivary C level could be a sensible and useful indicator of the adaptive training responses in youth soccer players submitted to systematic training processes, and that the absence of alteration in stress tolerance suggests that the athletes coped with the stress from the IT, and, indeed, indicates that salivary C concentration and a tool to monitor stress tolerance could be used together for effective training monitoring in such population.

However, despite evidence that youth athletes may properly cope with a well-designed periodization which includes an IT period followed by TP period, it is still unknown whether younger athletes, notably prepuberal athletes, could also undertake this type of training

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periodization approach. Habitually, rhythmic gymnasts (RG) begin their regular and systematic training for elite performance at young age [11], being exposed to years of practice and training at the early age of 6 years, continuing until adolescence [12]. Indeed, these young athletes are also exposed early to a high level of stress associated with the intense athletic training and the frequent competitions [11]. This scenario was presented, for example, by Georgopoulos et al. [11] who assessed 129 elite RG and 142 elite artistic gymnasts, aged 11–23 years. The RG athletes were evaluated during the 1999 Rhythmic Gymnastics World Championships in Osaka, Japan. For RG, the authors reported a mean age value of 7.7 (2.2) for onset of systematic training; a reported onset of breast development in the mean age of 13.4 years (1.6), and mean value of 15.2 years (1.4) for menarche. In addition, RG reported a mean training volume of 31.2 (9.6) hours of training per week.

Despite recognizing that these data might not be representative of gymnasts training today, and yet, might not be representative for all training regimens in different countries, these results well illustrate the actual RG training process in practical setting which submits youth athletes at early age to a substantial magnitude of training load, and that is habitually conducted even before the onset of puberty.

IT can lead to a high level of physical and/or mental fatigue [13–15]. Indeed, excessive training stimulus associated with inappropriate recovery might induce maladaptive responses, which in turn can lead to a decrease in athletic performance [16]. In addition, athletes seem to be at an increased risk of injury/illness at key phases of their training and competition, which includes periods of IT and periods of accumulated training loads [17]. Nonetheless, it is still unclear as to whether the IT in young prepubertal RG could negatively influence the hormonal milieu, the level of stress and the fatigue associated to well-being (WB), and as well as physical performance.

The advance of understanding about whether these youth female RG can cope with training load manipulation (IT and TP) may provide important information for both sports scientists and practitioners working with RG. As a result of a systematic investigation regarding the above-mentioned issues, the knowledge in this field could be extended while providing practical recommendations to optimize training planning and training monitoring in RG. Therefore, this study aimed to examine the effect of a 4-week intensified training period (IT) followed by a 2-week TP on salivary testosterone (T), salivary cortisol (C), perceived WB, and physical performance in youth RG.

2. Material and methods

2.1. Subjects

Twenty-five young RG (mean ± SD: age, 12.1 ± 2.6 years; height, 143.9 ± 13.7 cm; body mass, 37.2 ± 9.4 kg) volunteered to participate in this investigation. The only two inclusion criteria to take part in the present investigation, besides being part of the assessed teams were; 1) the participants must to be familiar with exercise training and testing procedures used in the investigation, and 2) have been trained regularly with the habitual training program of the assessed teams for at least 6 months before the commencement of the study. All 25 RG who initiated the training program contemplated these two inclusion criteria.

To include the subjects data in the final analysis, the following requirements were adopted: a) completing at least 75% of the training program in each of the investigated phases; b) completion of session rating of perceived exertion (s-RPE) to determine the ITL, and the daily questionnaire for WB; c) undertake all field tests and saliva collection; d) not present injuries during the investigation period; e) present hormonal concentrations within 2SD of the group mean, avoiding therefore including spurious data in the analysis; and f) RG should not achieve their peak height velocity (PHV). Data from 23 RG were retained for analysis. Data of 2 RG were excluded because they were 2 years after their PHV. The evaluated RG were from the Under-11 group (G1; n = 9; 10.2 ± 1.0 years; 133.3 ± 9.0 cm; 30.8 ± 5.5 kg); Under-13 group (G2; n = 7; 11.2 ± 0.9 years; 139.8 ± 6.1 cm; 33.2 ± 4.9 kg); and > 13 group (G3; n = 7; 14.9 ± 2.5 years; 159.7 ± 7.9 cm; 48.4 ± 5.6 kg), and competed in a State Rhythmic Gymnastics Championship in São Paulo, Brazil. After ethics approval by the local University Research Ethics Committee, all experimental procedures, risks and benefits were explained in detail to the RG and their respective parents or legal guardians provided written consent.

2.2. Experimental design

The study comprised 2 weeks of training monitoring during the habitual training (HT) of the RG, notably, for ITL and WB monitoring, followed by 4 weeks of IT which in turn was followed by 2 weeks of TP. Training was intensified with the addition of 40% of the habitual training (HT) volume performed by RG. The increased training volume was performed due to the inclusion of 2 or 3 more weekly sessions on the top of their usual week routine, and 1 additional hour training for each training session. During the IT period, RG performed 5–6 weekly training sessions which lasts 4 h each. During their HT period, RG completed 3–4 session per week, which lasted 3 h each. During the TP period, the training frequency was 3 training session per week, with each session lasted 2h30min (Fig. 1). The training session content was elaborated by coaches. They were instructed to maintain the same zone intensity for all training sessions throughout the entire investigation period. The training session content did not vary significantly over the experimental period. Training sessions were held at the beginning (1:30 PM) and at the end (5:30 PM) of the afternoon. The usual training content performed by assessed RG is presented in Table 1.

The session rating of perceived exertion (s-RPE) was used to quantify the ITL for each training session and the WB questionnaire was completed daily, on mornings, in order to analyze the level of stress and fatigue. All the RG were familiar with all these procedures. Physical performance tests and saliva collection were carried out at the beginning of the IT period (T1), after IT period (T2), and after TP period (T3). Athletes were required to have eaten their last meal at least 90 min before and not exercise for 44 h before saliva sampling and performance assessment. The samples were always collected at the team's training facility at 1:30 PM.

2.3. Maturity offset assessment

The same and experienced investigator carried out the anthropometrical measurements at all the time-points assessing. Maturity offset in years (time before or after the peak height velocity; PHV) was determined according to methods previously described by Mirwaldi et al. [18]. This approach has been used in the adolescent population and is considered a somatic maturation indicator [19]. This methodology predicts the time (years) before or after PHV from measures of height, body mass, sitting height, leg height and age. Only 2 RG of the 25 that initiated the study were above the PHV (+ 2 years after PHV). The data of these RG were not included in the analysis.

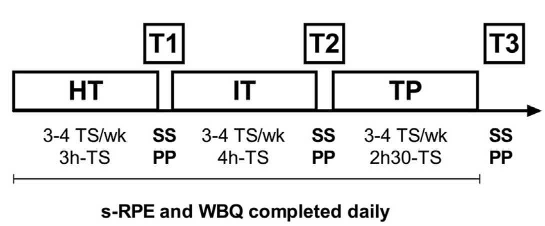

Fig. 1. Experimental design. HT = habitual training period; IT = intensification training period; TP = tapering period. T1 = beginning of the IT; T2 = after IT; T3 = after TP. SS = saliva sampling; PP = physical performance tests; TS = training session; s-RPE = session rating of perceived exertion; WBQ = well-being questionnaire.