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Effect of periodization on the physical capacities of basketball players of a military school

Efeito da periodização sobre capacidades físicas de basquetebolistas de um colégio militar

André de Assis Lauria [1]
https://orcid.org/0000-0003-4296-277X
Francisco Zacaron Werneck [2]
https://orcid.org/0000-0003-1966-8820
Dilson Borges Ribeiro Junior [3]
https://orcid.org/0000-0002-4616-1761
Jeferson Macedo Vianna [3]
https://orcid.org/0000-0003-1594-4429

Abstract – Basketball is a sport modality that imposes important physiological loads on players during competition. The aim of the study was to verify the effect of training with wave periodization on the physical capacities of athletes. Explosive strength of lower limbs; aerobic resistance; maximum strength of upper limb; and resting heart rate (HRrest) at PRE and POST moments of 16 athletes submitted to a 4-month training period were evaluated. The internal training load was monitored by the method proposed by Carl Foster in each training session. Statistically significant differences were observed in VO_2max of 50.5± 4.9 vs. 54.0± 6.1 ml/kg/min (p <0.000), in the vertical impulse of 39.1± 5.9 cm vs. 44.7± 5.9 cm (p <0.000), 10 RM on bench press 40.4± 9.4 vs. 48.0± 8.9 kg (p <0.000) and in HRrest 66± 4 vs. 60± 5 bpm (p <0.000). The average internal training load was 751± 249 AU. It was concluded that school basketball athletes submitted to training macrocycle with 4-month wave periodization improve the strength of lower and upper limbs, also presenting positive adaptations in aerobic conditioning.

Key words: Athletes; Basketball; Youth sports.

Resumo – *O basquetebol é uma modalidade que impõe cargas fisiológicas importantes aos jogadores durante a competição. O objetivo do estudo foi verificar o efeito do treinamento com periodização ondulatória sobre as capacidades físicas de jovens atletas. Foram avaliadas as capacidades de força explosiva de membros inferiores, resistência aeróbia, força máxima de membros superiores e avaliação da frequência cardíaca de repouso (FC_{rep}) nos momentos PRÉ e PÓS de 16 jovens basquetebolistas de um colégio militar, que foram submetidos a um período de 4 meses de treinamento. A carga interna de treinamento foi monitorada pelo método proposto por Carl Foster, em cada sessão de treinamento. Foram observadas diferenças estatisticamente significantes no $VO_{2máx}$ de 50,5±4,9 vs. 54,0±6,1 ml/kg/min (p<0,000), na impulsão vertical de 39,1±5,9 cm vs. 44,7±5,9 cm (p<0,000), no 10 RM no supino reto 40,4±9,4 vs. 48,0±8,9 kg (p<0,000) e na FC_{rep} 66±4 vs. 60±5 bpm (p<0,000). A carga interna de treinamento média foi de 751±249 UA. Conclui-se que atletas escolares de basquetebol submetidos a um macrociclo de treinamento com periodização ondulatória de 4 meses melhoram as capacidades de força de membros inferiores e superiores, apresentando também adaptações positivas no condicionamento aeróbico.*

Palavras-chave: *Atletas; Basquetebol; Esportes juvenis.*

1 Military School of Juiz de Fora. Juiz de Fora, MG. Brazil

2 Federal University of Ouro Preto. Ouro Preto, MG. Brazil

3 Federal University of Juiz de Fora. School of Physical Education and Sports. Juiz de Fora, MG. Brazil

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INTRODUCTION

Basketball is a modality that imposes important physiological loads on athletes during the training process and in competitions[1]. Consequently, physical conditioning is considered an important prerequisite for the competitive practice of modern basketball. Some studies[2-4] have emphasized the importance of varying daily training stimuli to achieve optimal performance. It is known[2,4] that good aerobic condition, associated with explosive strength levels of lower limbs, are paramount for the performance of athletes in this modality.

Training periodization offers an interesting structure for the planned and systematic variation of training parameters in order to direct physiological adaptations to the training objectives required by the sport[5]. Collective sports coaches[6-8], including basketball[9], have used periodization as a training strategy to prepare teams with the objective of achieving established performance goals[10]. During the training process, the need to know and control the internal training load (ITL) to monitor stimuli in order to generate positive training consequences and avoid negative training consequences has been observed[11]. The use of the Subjective Perception of Effort (SPE) method has proven to be effective to quantify individual ITL in professional and semi-professional basketball players[12-14]. This low-cost, easy-to-use tool represents a practical, reliable, and valid method for monitoring athlete's ITL.

There is evidence of the positive responses of the effect of training periodization on professional and semi-professional teams; however, there is lack of studies with school teams. Since there is a large number of coaches and athletes belonging to this category, there is need to verify the effect of training periodization on the physical capacities of basketball players in school teams. Evidences directed to this public are of paramount importance to subsidize coaches with respect to practical application. The aim of the present study was to verify the effect of training periodization on the physical capacities of basketball athletes of a military school.

METHOD

Sample

Sixteen male non-smokers, non-medicated individuals aged 15.5 (± 1.5) years, all athletes from the basketball team of the Military College of Juiz de Fora (CMJF) were evaluated. The frequency of athletes in each training session was controlled in order to verify adherence to the training process. Body mass, height, wingspan measurements were performed according to procedures adopted by Norton and Olds[15]. Body mass index was calculated using the following equation: body mass (kg)/squared height (m^2). During these measures, students were dressed in Physical Education uniform and barefoot. Athletes who did not return the informed consent form, those who refused to participate in tests and those who had any physical or clinical condition interfering with tests were excluded from the sample. The consent of legal guardians and the assent of students were obtained before their participation in the study. The study complied with standards for conducting research on human beings of the National Health Council, Resolution 196/96 of 10/10/1996. The research project was approved by the Research Ethics Committee involving Human Beings of the Federal University of Ouro Preto (CAAE: 32959814.4.1001.5150).

Periodization

Athletes underwent a 4-month training period comprising 16 weeks, with training frequency of 2 weekly sessions. Training macrocycle with wave periodization, structured in 2 periods, basic and specific, was elaborated. The basic period was composed of 6 training microcycles, and the specific period was composed of 10 training microcycles. Training sessions were performed with physical demand components, through exercises with strength, power and anaerobic strength stimuli, and technical and tactical demand components. Lower limb strength exercises were performed using plyometric work and free-weight squatting exercises. For the plyometric work, athletes performed a total of 1-2 sets of 5-10 jumps for each training section according to the programmed microcycle. Mini barriers of 35 cm in height were used to perform the work, and free-weight squatting exercises were performed, in which a total of 3-4 sets of 6-12 repetitions were performed. Free weights (dumbbells) with weights varying from 10 kg to 20 kg were used. Similarly, upper limb exercises were performed using the medicine ball throw (between 3 kg and 5 kg) and by arm flex on the ground using own body weight. The athletes selected the weights for the executions of exercises voluntarily and autonomously, but always guided by the coach to perform the weight increment whenever deemed necessary.

Anaerobic power and strength exercises were performed through situational exercises of game, based on the time of determined stimulus. Training microcycles were elaborated according to Bompa[16], in which 3 types of microcycles for the structuring of blocks were proposed, according to training phase and objective. The developmental microcycle (D) was used for the purpose of increasing skills and developing specific biomotor capacities; the Shock Microcycle (Ch) aimed at the sudden increase in training requirements above those commonly used, thus leading to the breaking of the adaptation limit reached in the previous phase, leading the athlete to reach higher organic limit; and Recuperative Microcycle (R), which aims to recover from fatigue and restore energy. Table 1 presents the training periodization structure elaborated and performed by athletes. Each training session had duration of up to 120 minutes, characterizing the session volume, and effort intensity was consistent with the wave periodization elaborated and registered by SPE.

Measurement of physical capacities

Muscle power (explosive strength) of the lower limbs was evaluated by means of the impulse test using vertical jump with counter movement (VJ) and a

Table 1. Training periodization structure

Training Macrocycle																
Months		March				April					May				June	
Weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Phase			Basic Period								Specific Period					
Microcycles	D	D	D	D	Ch	R	D	D	D	D	Ch	Ch	R	D	D	Ch

Note. Av - Evaluation; D - Development; Ch - Shock; R - Recuperative.

contact mat (Multi-SprintFull®, Hidrofit, Brazil). Hands were positioned on the height of hips, and participant was asked, from the standing position, to perform a quick squat and a vertical jump in sequence. Three jumps were made and the best result was considered. Aerobic strength was evaluated by the 20-meter shuttle run test[17]. The running pace is established by a sound signal. The test starts at speed of 8.5 km / h, with increment of 0.5 km / h at each 1-minute interval. The test ends when the participant stops due to fatigue or when he cannot reach the line at the same time of the sound signal, on two consecutive occasions. The last stage reached must be recorded for the calculation of the distance traveled. The relative VO_2max (ml / kg / min) was estimated by equation: $31.025 + 3.238 * V - 3.248 * I + 0.1536 * V * I$, where V = velocity in km / h of the last stage reached and I = age in years. The upper limb maximal strength test was performed through the 10 RM test on the bench press. To perform the 10 RM test, the following steps were used: specific warm-up exercises using loads that did not exceed 50% of the load estimated by the evaluator; allowing maximum of three attempts to reach the load for 10RM with 5-minute interval between attempts; the load used on the first attempt was determined by the evaluator based on the report of the subject's training experience; the increase in load between attempts was at least 2 kg. Resting heart rate (RHR) was obtained through Polar heart ratio meter model S810i, an instrument validated for measuring HR[18]. Subjects remained 10 minutes at rest in the seated position and the lowest measured frequency value was recorded. Tests were applied at PRE (beginning of training) and POST times (after the training period).

ITL measurement

ITL was monitored and recorded by the method proposed by Carl Foster [19] at each training session. ITL calculation, based on the Subjective Perception of Effort (SPE) method consists of multiplying the SPE score by the total session duration expressed in minutes (including warm-up, calm down and pauses between efforts, in the case of intermittent training). The product of SPE (intensity) by the session duration (volume) was expressed in arbitrary units (AU). An arithmetic mean of AU values of each week was performed to configure the weekly training load.

Statistical analysis

Data were expressed as mean ± standard deviation. To test differences in the capacities evaluated in PRE and POST conditions, the Student t test for dependent samples was performed. Analyses were performed by the Statistical Package for Social Science (SPSS - version 15.0). For all analyses, significance level of 5% ($p < 0.05$) was adopted.

RESULTS

The group of 16 athletes from the basketball team of CMJF, after the 4-month training period, obtained frequency in trainings of 87%. The profile of athletes who were included in the sample is characterized in table 2.

Table 2. Characteristics of sample subjects

	Mean	Standard Deviation
Age (years)	15.5	(±1.5)
Body Mass (kg)	72.3	(±12.8)
Height (m)	1.80	(± 0.08)
BMI (kg/m^2)	22.21	(±3.45)
Wingspan (m)	1.84	(± 0.10)

The results of the tests performed were compared between pre and post training periods. Statistically significant differences were observed in both lower limb and upper limb strength. In the vertical impulse test (VJ), values of 39.1 ± 5.9 cm vs. 44.7 ± 5.9 cm ($p < 0.000$) were obtained, and in the bench press (10 RM), values of 40.4 ± 9.4 Vs. 48.0 ± 8.9 kg ($p < 0.000$) were obtained. In aerobic capacity, significant statistical differences were also found. In VO_2max, values of 50.5 ± 4.9 Vs. 54.0 ± 6.1 (ml / kg / min) ($p < 0.000$), and in HR_{rest}, values of 66 ± 4 vs. 60 ± 5 bpm ($p < 0.000$) were obtained. Figure 1 shows the comparison of results obtained in tests at PRE and POST moments.

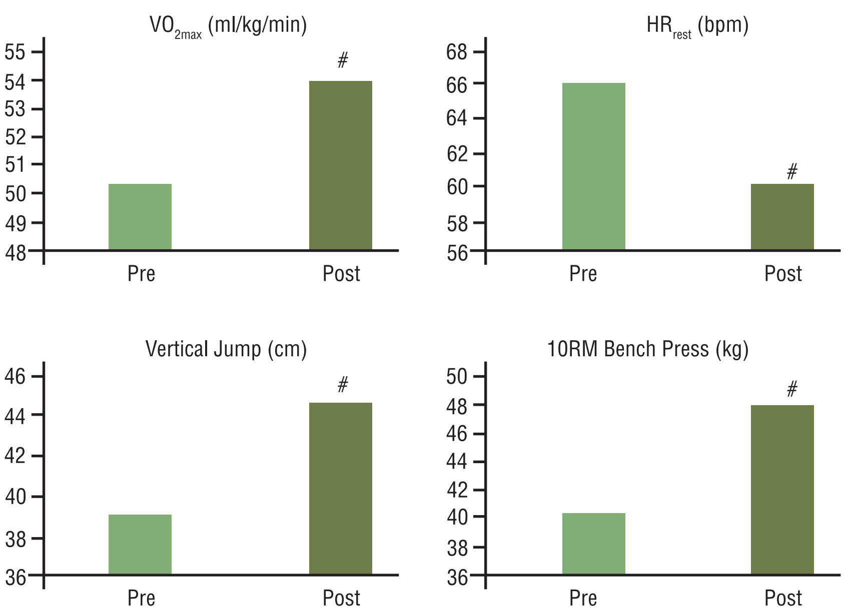

Figure 1. Comparison of VO_2max, HR_{rest}, Vertical Jump, 10RM Bench Press in the PRE and POST moments. # significantly different for the PRE moment ($p < 0.05$).

The mean ITL was 624 (± 262) AU, with minimum value of 240 AU and maximum value of 1020 AU. The ITL behavior throughout the training macrocycle was of wave characteristic, according to proposal. Figure 2 presents the ITL values referring to each of the 16 periodization training microcycles.

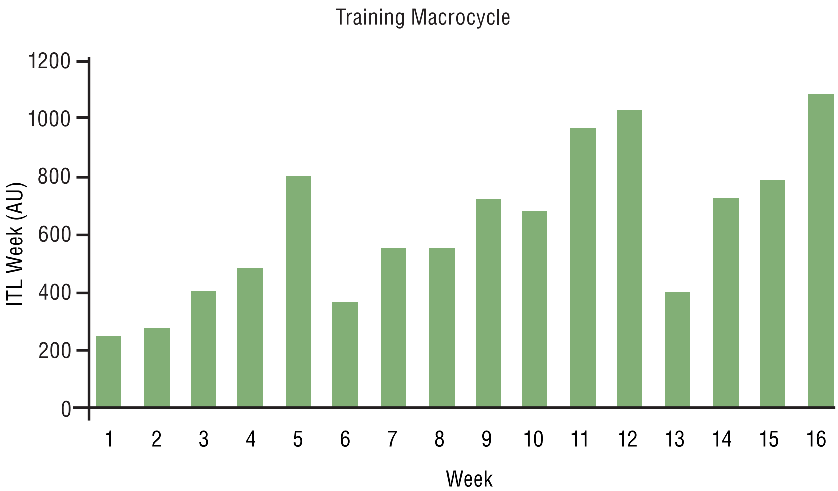

Figure 2. Internal training load (ITL) on arbitrary units (AU) of 16 week

DISCUSSION

The main finding of this study was that the physical and aerobic strength capacities of young basketball players showed improvement after 4 months of training with wave periodization. The results corroborate literature, which has demonstrated that physical training promotes improvements in the physical motor indicators of young athletes[20]. Improvement in upper and lower limb strength may have occurred due to a number of factors, including improved body segment synchronization, improved coordination, and increased muscle strength[21]. The results are in agreement with other literature findings for both plyometric training[22,23] and free-weight training[24]. Some of these investigations have chosen evaluation protocols different from those of this work to measure vertical impulsion, such as with the help of upper limbs. There are also different strength training programs and objectives. These results confirm, like this study, that vertical impulsion can be increased after the application of strength work in students, even with training processes different from those presented in literature.

The positive adaptations in the aerobic conditioning of athletes in the present study were verified through the improvement of VO_2max and reduction of HR_{rest}. Although the preparation program was based on short-duration, high- intensity and low-frequency activities, it was verified that physical exercises with predominance of the anaerobic system and technical-tactical training with intermittent characteristics provided important improvements in the physical aerobic conditioning. The results are in line with other studies that concluded that high- intensity training represents the best stimulus for the development of aerobic capacity in basketball players[25,26]. HR_{rest} values were significantly lower when compared to the PRE moment. It is possible that the response found is due to the fact that training leads to alterations in the autonomic balance, suggesting greater parasympathetic activity or less sympathetic activity[27]. In addition, some circulatory alterations such as improvement of the venous return and increase of the systolic volume can reduce HR in aerobically conditioned individuals[28].

ITL control was performed using the SPE method in each training section. The mean values found in the present study were 624 ± 262 AU, with minimum value of 240 AU and maximum value of 1020 AU. The values found are similar to values presented by Manzi[12], in which the competitive season of professional basketball athletes found average ITL values of 522 AU. Similar values were observed in amateur basketball athletes during the preparation period[13].

Although there are few studies in Brazil about training periodization in school athletes, especially in collective sports, it was verified that the periodization model used in an adapted way can be applied, bringing important benefits to the physical performance of athletes. It is important to emphasize in this discussion that the present study, despite its novelty and importance of findings discussed here, both with regard to nature (longitudinal) and external validity, has a relative limitation regarding the lack of control of the biological maturation of athletes. It is known that biological maturation exerts a significant influence on physical performance parameters, particularly in boys aged 13-15 years[29]. In this sense, the design of the present study does not allow inferring to what extent the observed changes can in fact be attributed to training or maturation alone. Therefore, more biologically advanced athletes typically demonstrate better performance in skills that require strength and speed. The generalization of results should be analyzed within the context of basketball and in the reality of a school team.

CONCLUSION

Based on results, it could be concluded that school basketball athletes submitted to 4-month training macrocycle with wave periodization, with frequency of 2 weekly training sessions, improve upper and lower limb strength and also showed positive adaptations in aerobic conditioning. Further studies should be carried out evaluating other specific abilities, follow-up with longer intervention periods, as well as the use of control group and measurement of the effect of biological growth and maturation processes on the gain of acquired abilities.

COMPLIANCE WITH ETHICAL STANDARDS

Ethical approval

This study is an integral part of the " Projeto Atletas de Ouro: Multidimensional and Longitudinal Evaluation of Young Athletes' Sports Potential", approved by the Research Ethics Committee of the Federal University of Ouro Preto (CAAE: 3295814.4.1001.5150).

Conflict of interest statement

The authors have no conflict of interests to declare.

Author Contributions

Conceived and designed the experiments: AAL; FZW; DBRJ and JMV. Performed the experiments: AAL; FZW; DBRJ and JMV. Analyzed data: AAL and FZW. Contributed with reagents/materials/analysis tools: AAL; FZW; DBRJ and JMV. Wrote the paper: AAL; FZW; DBRJ and JMV.

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Corresponding author
André de Assis Lauria
Avenida Presidente Costa e Silva, 2391
CEP: 36037-000 - São Pedro, Juiz de Fora, MG. Brasil.
Email: lauria_aa@hotmail.com