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Physical-motor indicators and specific skills of young basketball players after periodization training

Indicadores físico-motores e habilidades específicas de jovens basquetebolistas após treinamento com periodização

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Abstract – Basketball is a team sport with short, high intensity movement patterns and rapid and frequent changes of direction. Strength, agility and speed, in addition to specific technical skills, are essential for basketball athletes to achieve good performance. This study aims to verify the effect of a traditional periodization on physical-motor indicators and on specific technical skills in young basketball players. Nineteen young basketball players (15.4 ± 1.3 years), with at least 12 months of training experience, underwent a 5-month periodization. We assessed two physical-motor indicators (countermovement jump (CMJ) and anaerobic capacity (Line Drill)) and two specific technical skills (Dribbling and Shooting) at the PRE and POST training moments. Paired Student's t test was used to test the effect of training on physical-motor variables and technical skills. We calculated the 95% confidence interval of the average relative gain (Δ%) for each variable and analyzed the effect size through Cohen's d (p≤ 0.05). Significant differences were found between the PRE and POST moments in the CMJ (34.02 vs. 38.64 cm; p <0.001), in the Line-Drill (33.20 vs. 31.73 s; p <0.001), Dribbling (6.95 vs. 6.66 s; p <0.001), and Shooting (15.84 vs. 17.95 pts; p <0.001). Young school-level basketball players submitted to a 5-month training period were able to improve their physical-motor indicators and specific skills.

Key words: Athletes; Basketball; Youth sports.

Resumo – *O basquete é um esporte coletivo com padrões de movimentos curtos, de alta intensidade e com mudanças rápidas e frequentes de direção. Níveis elevados de força, agilidade e velocidade, além de habilidades técnicas específicas, são primordiais para uma boa performance em atletas desta modalidade. O objetivo do estudo foi verificar o efeito de uma periodização tradicional nos indicadores físico-motores e nas habilidades técnicas em jovens basquetebolistas. Dezenove jovens basquetebolistas (idade: 15,4 ± 1,3 anos, estatura: 172,80 ± 7,90 cm), com pelo menos 12 meses de experiencia em treinamento, foram submetidos a uma periodização de 5 meses. Foram avaliados, nos momentos PRÉ e PÓS treinamento dois indicadores físico-motores (salto vertical com contramovimento (CMJ); e capacidade anaeróbica (Line Drill)) e duas habilidades técnicas específicas (Arremesso e Drible). Para testar o efeito do treinamento sobre as variáveis físico-motoras e habilidades técnicas, foi utilizado o teste de t de Student pareado. Foi calculado o intervalo de confiança de 95% da média do ganho relativo (Δ%) em cada variável. O tamanho do efeito foi analisado pelo d de Cohen (p≤ 0.05). Foram encontradas diferenças significativas entre os momentos PRÉ e PÓS no CMJ (34,02 vs. 38,64 cm; p<0,001), no Line-Drill (33,20 vs. 31,73 s; p<0,001), no Drible (6,95 vs. 6,66 s; p<0,001) e no Arremesso (15,84 vs. 17,95 pts; p<0,001). Conclui-se que jovens basquetebolistas de nível escolar, submetidos a uma periodização do treinamento de 5 meses, melhoram a potência de membros inferiores, a capacidade anaeróbica e as habilidades de drible e arremesso.*

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

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INTRODUCTION

Basketball is a sport that imposes high physiological load on athletes[1], and it is characterized by the frequent execution of low- and high-intensity activities[2]. The basketball demands affect the balance of the internal environment, promoting changes in parameters such as lactate concentration, heart rate (HR), and subjective perception of exertion (PSE)[3,4]. The time-movement analysis data show that basketball consists of active phases lasting up to 20 seconds and that players perform approximately 1000 movement changes during the games[5]. Consequently, physical conditioning is considered an important prerequisite for the competitive practice of modern basketball, demanding, for example, a good aerobic condition and an explosive strength of the lower limbs. Some studies have highlighted the importance of varying the daily training stimuli to achieve optimal performance[6,7].

Training periodization implies a planned and systematic variation in the training load in order to direct physiological adaptations toward the objectives of each session[8]. Periodization is a training strategy to prepare teams in order reach the performance goals established[9]. The most common periodization models adopted in basketball include traditional and block periodization. In the traditional model, macrocycles and mesocycles are organized for the transition from high-volume and low-intensity workloads to high-intensity and low-volume workloads. Moreover, this model is based on the simultaneous development of many physical abilities throughout the season (e.g., aerobic capacity, strength, power)[10].

Studies with young basketball players are limited to the analysis of anthropometric and functional characteristics of elite and non-elite players[11], as well as young athletes classified by age group and sexual maturation status[12]. In contrast, the literature has very few reports of longitudinal studies in young basketball players. In school teams, for example, training is much different from that of professional adult teams, especially in regard to the time left available for training after dedicating to school and training activities. Therefore, training loads and contents in school athletes tend to a different organization from professional adult athletes, thus implying the need to investigate the responses of young school athletes to different training load organizations. Therefore, our goal was to verify the effect of a planned training according to traditional periodization on physical-motor indicators and technical skills in young school basketball players.

METHOD

Participants

Nineteen young male school basketball athletes, aged 15.4 ± 1.3 years, participated in the study. The athletes trained twice a week and participated annually in intercollegiate games at the national level. Inclusion criteria were: a) experience of at least 12 months of systematized basketball training and b) regular attendance at the training sessions of the teams. We disregarded any data from athletes who did not perform all the proposed tests or those who presented any physical or clinical condition that interfered with the tests. Participants and

their legal representatives were informed about the research procedures and signed consent forms for participation. The study was approved by the local research ethics committee (CAAE: 32959814.4.1001.5150).

Instrumens and procedures

This study is part of the Atletas de Ouro® Project: Multidimensional and Longitudinal Evaluation of Sporting Potential in Young Athletes. The study procedures involved three stages: the PRE moment (characterization of the sample and the battery of tests of physical-motor indicators and specific skills), the intervention moment (application of training periodization), and the POST moment (battery of tests of physical-motor indicators and specific skills). For sample characterization, we performed anthropometric measurements (body mass, height, and wingspan), as well as the evaluation of aerobic capacity and somatic maturation.

The Yo-yo Intermittent Recovery Test level 1 assessed the aerobic capacity and estimated from the distance traveled in the test through the equation (VO_{2max} (ml-kg^{-1}-min^{-1}): distance traveled in the Yoyo test (m)*0.0084+36.4)[11].

Biological maturation was assessed based on somatic maturation indicators: 1) percentage of predicted adult height attained (%PMS); 2) predicted age at peak growth velocity in height (age at PHV). The Khamis and Roche method was applied to estimate the predicted adult height was estimated through the relationship of the individual's chronological age, current height, and body mass with the respective biological parents' height [13]. The maturational indicator %PMS was then calculated by the following equation: %PMS = (current height / predicted adult height) * 100. The higher the %PMS the closer the subject is to the mature (adult) stage. From the reference data by age group and sex, the Z scores were calculated to obtain the maturational stage classifications of the evaluated in delayed, normomature or advanced. The predicted age at PVH was estimated by means of specific prediction equations, based on the individual's chronological age and anthropometric measurements, in addition to the calculation of the maturity offset (MO), which represents the distance, in years, that the subject is from the PHV. The maturational indicator Age at PHV was then estimated by the following equation: Age at PHV = current chronological age – (MO)[14]. Negative values indicate that the youngster has not yet reached PHV, while positive values indicate that the youngster has already reached PHV.

The physical-motor indicators here assessed correspond to the lower limb muscular power and anaerobic power evaluation. The lower limb muscle power was assessed by means of the height of the vertical jump with countermovement (CMJ) using a contact mat. Three jumps were performed and the best result was considered. For the anaerobic evaluation, the Line Drill test was applied in a single maximum attempt[15]. Finally, two basketball-specific skills were tested, shooting and dribbling, following the procedures adopted by Silva[16], as described below:

Shooting

The participants started the test behind any one of the five markers placed on the floor approximately 4.54 m from the basket. The players were instructed

to shoot, retrieve the ball, dribble to another desired position, and repeat the process as quickly as possible for 60 seconds. The athletes were required to take at least one shot from each mark. A maximum of four tray throws were allowed during each attempt, but not successively. Two (2) points were considered for each basket converted, including the tray shot, and one (1) point for an unsuccessful shot that hit the top edge of the rim. In the end of the protocol, the points were added up, thus totaling the final score of the specific skill.

Dribbling

The participants ran through a dribbling circuit defined by five cones within a rectangle measuring 5.80 meters as fast as possible. The time required to complete the circuit was recorded with an accuracy of 0.01 seconds, using a set of photocells connected to a digital timer. Two attempts were made and the best time was considered.

Periodization

The subjects were submitted to a 5-month training period as often as twice a week, totaling 20 weeks (microcycles) and 39 training sessions. The athletes followed a training macrocycle of undulatory characteristic, structured in basic and specific periods. The basic period was composed of 8 microcycles and aimed at increasing several physical abilities, whereas the specific period, composed of 12 microcycles, aimed at increasing the specificity of the training and promoting a special interrelation of physical, technical, tactical, and psychological preparation.

The training microcycles were elaborated following the proposal by Bompa and Haff[17]: 1) evaluation microcycle (Ev) test applications at the pre- and post-moments; 2) development microcycle (D) aimed at increasing technical-tactical conditioning and developing specific physical-motor capacities; 3) stabilization microcycle (S), maintenance of training loads from the previous week; 4) shock microcycle (Sh), sudden elevation of training demands, promoting an increase in training volume and intensity; 5) recovery microcycle (R), lower training volume and intensity.

The training session

The training sessions consisted of performing the following procedures:

(a) strength training with different objectives (muscle hypertrophy, maximum strength or muscle power, strength endurance, according to the periodization), performed with one's own body weight or using implements such as medicine ball, dumbbells, mini barriers and steps of the gym bleachers. The strength training was performed with exercises in a mixed-circuit format, alternating motor coordination, core, and balance exercises;

(b) Technical and tactical training based on the situational global method, in situations of numerical equality, superiority, and inferiority in the full court, half court, and quarter court, with and without time pressure. All training sessions consisted of a warm-up period, a main part, and a cool-down period. The adjustments in the training loads, aiming to follow the proposed periodization, were performed considering two aspects: 1) Adjustment

of training volume (increasing or decreasing the session duration) and 2) Adjustment of the training intensity, established by increasing weights, speed of execution in strength exercises, and in the manipulation of technical-tactical training conditions (T-TC).

The strength training exercises encompassed: Arm Curl, Squat, Abdominal Trunk Flexion, and Static Plank. For all exercises, a total of 3 sets were performed with the number of repetitions varying according to the objective: 15 repetitions for strength endurance, 10-12 reps for hypertrophy, and 6-8 reps for maximum strength. For the Abdominal exercise, a total of 20 to 30 reps were performed, and for the Plank exercise, a time of 30" to 40" was performed for each set. The subjects selected the weights to execute the exercises voluntarily, but always oriented by the trainer to increase the weight after performing two repetitions more than expected. In the shock microcycles, 2 additional exercises were performed: medicine ball throw (3 x 10 throws) and barrier jumps (3 x 10 jumps). Box 1 shows the objectives and training loads for the 20 weeks analyzed.

Box 1. 20-week training program.

Weeks	Periods	Microcycles	Strength **variables**	Adjustments to training loads
1	Basic	D	Hyp (3 x 10-12 reps)	-
2-3		S-S	-	-
4		D	Hyp (3 x 10-12 reps)	↑ Vol (↑ Duration)
5		Sh	Str (3 x 6-8 reps)	↑ Int (↑ Str and ↑ T-TC)
6		R	End (3 x 15 reps)	↓ Vol (↓ Duration) and ↓ Int (↓ Str and ↓ T-TC)
7		D	Hyp (3 x 10-12 reps)	↑ Vol (↑ Duration) and ↑ Int (↑ Str)
8-9		S-S	-	-
10	Specific	D	Hyp (3 x 10-12 reps)	↑ Vol (↑ Duration)
11		S	-	-
12		Sh	Str (3 x 6-8 reps)	↑ Vol (↑ Duration) and ↑ Int (↑ T-TC and ↑ Str)
13		R	End (3 x 15 reps)	↓ Vol (↓ Duration) and ↓ Int (↓ Str and ↓ T-TC)
14		D	Hyp (3 x 10-12 reps)	↑ Vol (↑ Duration) and ↑ Int (↑ Str)
15-16		S-S	-	-
17		D	Hyp (3 x 10-12 reps)	↑ Vol (↑ Duration)
18		S	-	-
19		Sh	Str (3 x 6-8 reps)	↑ Int (↑ Str and ↑ T-TC)
20		R	End (2 x 15 reps)	↓ Vol (↓ Duration) and ↓ Int (↓ Str and ↓ T-TC)

D: development; S: stabilization; Sh: shock; R: recovery; Hyp: hypertrophy; Str: strength; End: endurance; Vol: volume; Int: intensity; Duration: duration of the session; T-TC: technical-tactical training conditions; ↑: increase; ↓ decrease.

Measurement of the internal training load

We assessed the internal training load based on the PSE-session[4]. The PSE value provided by the athlete was multiplied by the total duration of the session in minutes, resulting in the PSE-session, expressed in arbitrary units (AU). All subjects had been properly familiarized with the tool in the previous season.

Statistical analysis

The descriptive analysis of the data is expressed as mean and standard deviation and a Shapiro-Wilk test validated the data normality assumption. A paired Student's t-test was applied to test the effect of training on physical-motor variables and technical skills. The 95% confidence interval of the mean relative gain (Δ%) in each variable was calculated. The effect size was analyzed

by Cohen's d[18] based on the following classification: small 0.20 - 0.49, moderate 0.50 - 0.79: high ≥ 0.80. All analyses were performed on the IBM SPSS software version 24.0 (IBM Corp., Armonk, NY). Values of $p \leq 0.05$ were considered statistically significant.

RESULTS

Table 1 shows the data of the participants characterization. For somatic maturation, 10 athletes (52.6%) were classified as normature and 9 (47.4%) as advanced.

Table 1. Participant's characteristics (n = 19).

Variables	Minimum	Maximum	Mean	Standard Deviation
Body Mass (kg)	44,80	87,50	63,09	10,15
Height (cm)	156,20	186,70	172,88	7,90
Wingspan (cm)	161,00	196,00	176,73	8,96
Distance Yoyo rec (m)	480,00	1260,00	771,58	208,09
VO2máx (ml-kg-1-min-1)	40,43	46,98	42,88	1,75
age at PHV	12,90	15,20	13,85	0,52
PMS	161,60	191,20	178,85	6,91
%PMS	91,20	100,00	96,66	2,65
Experience (months)	12,00	36,00	18,00	7,84
% Frequency (TS)	87,20	100,00	92,70	4,78

PHV: peak height velocity; PMS: predicted adult height; %PMS: percentage of predicted adult height attained; TS: training session.

Figure 1 shows the average internal training load of the athletes during the training period (average: 596 (± 204) AU; minimum 249 AU; maximum 960 AU), observing the undulatory characteristic of the recommended proposal.

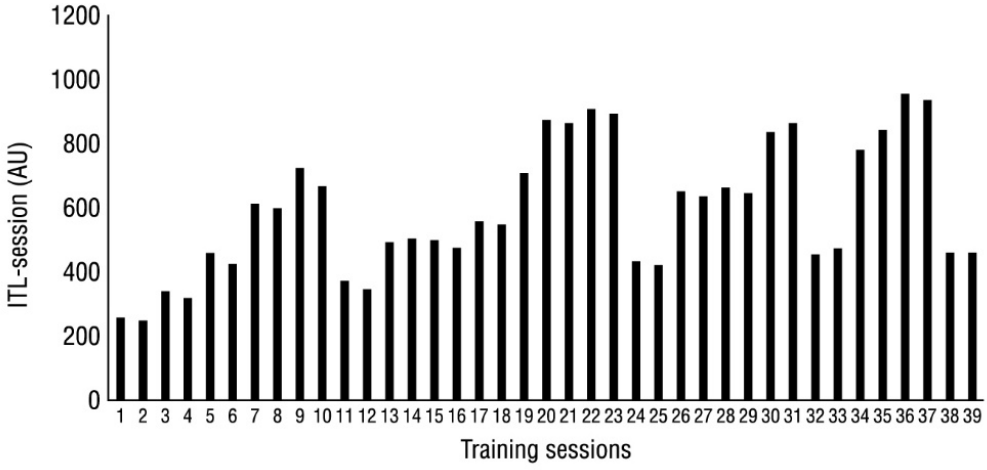

Figure 1. Internal training load (ITL) in arbitrary units (AU) of 39 training sessions.

Table 2 shows the values (mean ± SD) of the physical-motor indicators and specific skills at the PRE and POST moments, confidence interval, p value found in the t test ($p \leq 0.05$) and effect size (Cohen's d). Figure 2 presents the results regarding the 95% confidence interval of the relative gain (%) observed in physical-motor indicators, and technical skills in young basketball players after 5 months of periodized training.

Table 2. Mean ± SD of the physical-motor indicators and specific skills at the PRE and POST moments.

Variables	PRE	POST	IC95%dif	p-value	ES
CMJ (cm)	34,02±5,99	38,64±6,09	3,63 - 5,62	≤0,001	0,77
Line-Drill (seconds)	33,20±1,73	31,73±1,67	-1,00 - -1,84	≤0,001	0,87
Dribbling (seconds)	6,95±0,69	6,66±0,61	-0,19 - -0,38	≤0,001	0,41
Shooting (point)	15,84±3,08	17,95±3,42	1,14 - 3,07	≤0,001	0,68

CMJ: countermovement jump; IC95dif%: confidence interval 95%; ES: effect size Cohen's d.

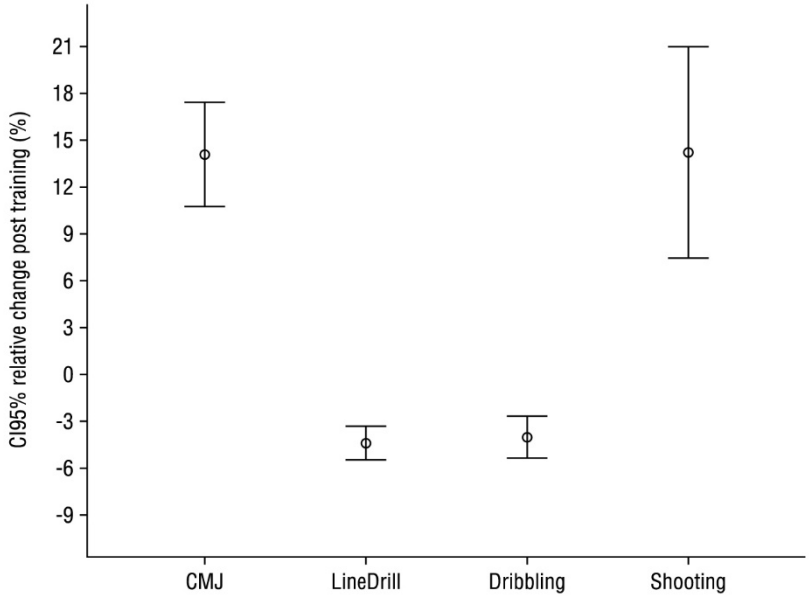

Figure 2. 95% confidence interval of the relative gain (%) observed in physical-motor indicators and technical skills in young basketball players after 5 months of periodized training.

DISCUSSION

The aim of this study was to investigate the effect of traditional periodization training on physical-motor indicators and specific technical skills of young school basketball players. We observed an improvement of physical-motor indicators and specific skills after 5 months of periodized training, which is in accordance with the literature on physical training of young athletes[19].

Regarding the improvement of physical-motor indicators, several studies have reported the improvement of vertical jump in young athletes submitted to several types of training stimuli, such as strength training with weights[20], and specific basketball training[21]. The improvement in anaerobic capacity, measured through the Line-Drill test, has been reported in studies with young basketball players undergoing training, regardless of maturation stage[22] and body size[23]; it is worth highlighting that the test is validated with great specificity for this sport. In this study, the periodization of strength training, along with the other conditions already reported, may have contributed to the positive effect on physical-motor indicators. Such result agrees with other findings reporting the positive effect of strength training on young basketball players[24].

Our training periodization proposal involved multiple stimuli throughout the training process, including plyometric training, strength training with weights, integrated circuits, in addition to technical and tactical trainings that promote a

significant amount of jumping. The improvement in physical-motor indicators may have resulted from a number of factors, including better synchronization of body segments, enhanced motor coordination, and greater muscle strength[19]; in addition to the level of maturation[25], since the subjects were all normomature or advanced. Furthermore, young people experience periods of rapid growth that represent large windows of opportunity to improve their physical condition. If the workloads are applied at the right time, training adaptations within these sensitive periods can be optimized[26].

Based on our results, the specific technical skills of shooting and dribbling seem to improve significantly over a 5-month training period in young basketball players. The training conducted for this study ranged the performance of specific stimuli monitored by means of intensity and with adjusted weights and speed of execution in strength exercises and manipulation of technical-tactical training conditioning. Specific technical skills have a primary role in basketball performance[16], and their improvement is related to basketball-specific training[27]. A cross-sectional study observed better shooting and dribbling performances in young basketball players in relation to younger individuals. However, the length of experience in playing the sport influences the level of technical ability and physical performance[28].

The traditional periodization model applied in this study proved to be adequate and to provide positive results regarding the investigated parameters. This model has offered relevant efficacy when applied to male basketball teams of the same age group showing significant performance development[29]. Internal training load was controlled through the PSE-session. Our mean values are similar to those found in studies of similar nature and sample[22]. Amateur basketball athletes also presented analogous values during the preparation period[30], suggesting that the training load applied and perceived by basketball players was consistent with the positive adaptations found.

This study main limitation is the impossibility of implementing a control group. Therefore, we suggest that further investigations use a control group and a multidimensional approach, including other components (e.g., tactical skills, perceptual-cognitive skills, individual psychological characteristics, and other issues relevant to training and competition).

CONCLUSION

We conclude that young school-level basketball players undergoing a five-month periodized training in a traditional manner were able to improve their physical-motor indicators and specific technical skills.

COMPLIANCE WITH ETHICAL STANDARDS

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Ethical approval

Ethical approval was obtained from the local Human Research Ethics Committee Federal University of Ouro Preto and the protocol (no. 817.671) was written in accordance with the standards set by the Declaration of Helsinki.

Conflict of interest statement

The authors have no conflict of interests to declare.

Author Contributions

AAL, DBRJ, FZW conceived and designed the experiments; AAL, DBRJ, SGTB, FZW performed the experiments; AAL, FZW analyzed the data; AAL, FZW contributed reagents/materials/analysis tools; AAL, DBRJ, SGTB, FZW edited the manuscript.

REFERENCES

1. McInnes SE, Carlson JS, Jones CJ, McKenna MJ. The physiological load imposed upon basketball players during competition. J Sports Sci. 1995;13(5):387-97. http://dx.doi.org/10.1080/02640419508732254. PMid:8558625.
2. Ben Abdelkrim N, Castagna C, Jabri I, Battikh T, El Fazaa S, El Ati J. Activity profile and physiological requirements of junior elite basketball players in relation to aerobic-anaerobic fitness. J Strength Cond Res. 2010;24(9):2330-42. http://dx.doi.org/10.1519/JSC.0b013e3181e381c1. PMid:20802281.
3. Rodríguez-Alonso M, Fernández-García B, Pérez-Landaluce J, Terrados N. Blood lactate and heart rate during national and international women's basketball. J Sports Med Phys Fitness. 2003;43(4):432-6. PMid:14767402.
4. Foster C, Florhaug JA, Franklin J, Gottschall L, Hrovatin LA, Parker S, et al. A new approach to monitoring exercise training. J Strength Cond Res. 2001;15(1):109-15. PMid:11708692.
5. Conte D, Tessitore A, Smiley K, Thomas C, Favero TG. Performance profile of NCAA Division I men's basketball games and training sessions. Biol Sport. 2016;33(2):189-94. http://dx.doi.org/10.5604/20831862.1200512. PMid:27274114.
6. Apostolidis N, Nassis GP, Bolatoglou T, Geladas ND. Physiological and technical characteristics of elite young basketball players. J Sports Med Phys Fitness. 2004;44(2):157-63. PMid:15470313.
7. Sallet P, Perrier D, Ferret JM, Vitelli V, Baverel G. Physiological differences in professional basketball players as a function of playing position and level of play. J Sports Med Phys Fitness. 2005;45(3):291-4. PMid:16230979.
8. Rhea MR, Ball SD, Phillips WT, Burkett LN. A comparison of linear and daily undulating periodized programs with equated volume and intensity for strength. J Strength Cond Res. 2002;16(2):250-5. PMid:11991778.
9. Gamble P. Periodization of training for team sports athletes. Strength Condit J. 2006;28(5):56-66. http://dx.doi.org/10.1519/00126548-200610000-00009.
10. Pliauga V, Lukonaitiene I, Kamandulis S, Skurvydas A, Sakalauskas R, Scanlan AT, et al. The effect of block and traditional periodization training models on jump and sprint performance in collegiate basketball players. Biol Sport. 2018;35(4):373-82. http://dx.doi.org/10.5114/biolsport.2018.78058. PMid:30765923.

11. Castagna C, Impellizzeri FM, Rampinini FM, D'Ottavio S, Manzi V. The Yo-Yo intermittent recovery test in basketball players. J Sci Med Sport. 2008;11(2):202-8. http://dx.doi.org/10.1016/j.jsams.2007.02.013. PMid:17574917.

12. Drinkwater EJ, Hopkins WG, McKenna MJ, Hunt PH, Pyne DB. Modelling age and secular differences in fitness between basketball players. J Sports Sci. 2007;25(8):869-78. http://dx.doi.org/10.1080/02640410600907870. PMid:17474040.

13. Khamis HJ, Roche AF. Predicting adult stature without using skeletal age: the Khamis-Roche method. Pediatrics. 1994;94(4):504-7. PMid:7936860.

14. Mirwald RL, Baxter-Jones ADG, Bailey DA, Beunen GP. An assessment of maturity from anthropometric measurements. Med Sci Sports Exerc. 2002;34(4):689-94. PMid:11932580.

15. Carvalho HM, Gonçalves CE, Collins D, Paes RR. Growth, functional capacities and motivation for achievement and competitiveness in youth basketball: an interdisciplinary approach. J Sports Sci. 2018;36(7):742-8. http://dx.doi.org/10.1080/02640414.2017.1340654. PMid:28604286.

16. Silva RMC, Figueiredo AJ, Carvalho HM, Malina RM. Functional capacities and sport-specific skills of 14- to 15-year-old male basketball players: size and maturity effects. Eur J Sport Sci. 2008;8(5):277-85. http://dx.doi.org/10.1080/17461390802117177.

17. Bompa T, Haff G. Periodization: theory and methodology of training. Leeds: Human Kinetics; 2009.

18. Cohen J. A power primer. Psychol Bull. 1992;112(1):155-9. http://dx.doi.org/10.1037/0033-2909.112.1.155. PMid:19565683.

19. Santos EJAM, Janeira MAAS. Effects of complex training on explosive strength in adolescent male basketball players. J Strength Cond Res. 2008;22(3):903-9. http://dx.doi.org/10.1519/JSC.0b013e31816a59f2. PMid:18438223.

20. Hoffman JR, Maresh CM, Armstrong LE, Kraemer WJ. Effects of offseason and in-season resistance training programs on a collegiate male basketball team. J Hum Muscle Perform. 1991;1(2):48-55.

21. Lauria AA, Werneck FZ, Ribeiro DB Jr, Vianna JM. Effect of periodization on the physical capacities of basketball players of a military on the school. Rev Bras Cineantropom Desempenho Hum. 2019;21:e59818.

22. Carvalho HM, Silva MJC, Figueiredo AJ, Gonçalves CE, Castagna C, Philippaerts RM, et al. Cross-validation and reliability of the line-drill test of anaerobic performance in basketball players 14-16 years. J Strength Cond Res. 2011;25(4):1113-9. http://dx.doi.org/10.1519/JSC.0b013e3181d09e38. PMid:20733528.

23. Carvalho HM, Gonçalves CE, Grosgeorge B, Paes RR. Validity and usefulness of the Line Drill test for adolescent basketball players: a Bayesian multilevel analysis. Res Sports Med. 2017;25(3):333-44. http://dx.doi.org/10.1080/15438627.2017.1314296. PMid:28391721.

24. Santos EJ, Janeira MA. The effects of resistance training on explosive strength indicators in adolescent basketball players. J Strength Cond Res. 2012;26(10):2641-7. http://dx.doi.org/10.1519/JSC.0b013e31823f8dd4. PMid:22108528.

25. Guimarães E, Baxter-Jones A, Maia J, Fonseca P, Santos A, Santos E, et al. The roles of growth, maturation, physical fitness, and technical skills on selection for a portuguese under-14 years basketball team. Sports. 2019;7(3):61. http://dx.doi.org/10.3390/sports7030061. PMid:30857137.

26. Guimarães E, Maia JAR, Williams M, Sousa F, Santos E, Tavares F, et al. Muscular strength spurts in adolescent male basketball players: the INEX study. Int J Environ Res Public Health. 2021;18(2):776. http://dx.doi.org/10.3390/ijerph18020776. PMid:33477582.

27. Karpowicz K. Interrelation of selected factors determining the effectiveness of training in young basketball players. Hum Mov Sci. 2006;7:130-46.

28. Guimarães E, Baxter-Jones ADG, Williams AM, Tavares F, Janeira MA, Maia J. The role of growth, maturation and sporting environment on the development of performance and technical and tactical skills in youth basketball players: the INEX study. J Sports Sci. 2021;39(9):979-91. PMid:33225823.

29. Balčiūnas M, Stonkus S, Abrantes C, Sampaio J. Long term effects of different training modalities on power, speed, skill and anaerobic capacity in young male basketball players. J Sports Sci Med. 2006;5(1):163-70. PMid:24198694.

30. Scanlan AT, Wen N, Tucker PS, Borges NR, Dalbo VJ. Training mode's influences on the relationships between training-load models during basketball conditioning. Int J Sports Physiol Perform. 2014;9(5):851-6. http://dx.doi.org/10.1123/ijspp.2013-0410. PMid:24434042.