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Implementing Complex Training Method: Its Effects on Endurance, Speed, Power, and Agility of Adolescent Basketball Players

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Abstract

Objectives. This study aimed to examine the effectiveness of complex training on aerobic endurance, speed, power, and agility in adolescent basketball players.

Materials and methods. Field testing experimental research method was used in the study. Purposive sampling was conducted, with participants meeting the following criteria: (1) basketball players training at one club, (2) males, (3) having daily training at one club, and (4) being in good health. A total of 16 participants were involved with a body weight of ± 60-80 kg, and a height of 170-190 cm. Observation data collection techniques, review of relevant articles, and tests were used in order to obtain the required material. To ensure the assessment of physical aspects, the following tests and instruments were applied: Jump DF instrument, Multistage fitness test, 20-meter sprint, lane agility test. The Friedman test data analysis technique was performed using the statistical software program SPSS 23.

Results. The average score for the first endurance test was 48.53, with the second and third tests demonstrated the results of 50.01 and 52.47, respectively. Similarly, the average speed test score achieved in the first was 3.20, the second was 3.18, and the third – 2.97. The average score for the first agility test was found to be 11.66, the second showed 11.70, and the third – 10.57. The average for the first leg muscle strength test was 66, while the second and third tests were found to be 65 and 69, respectively. The Friedman test variables were used to determine differences in aerobic endurance, speed, power, and agility, the overall significance value was 0.000<0.05.

Conclusions. The implementation of a complex training method for 24 sessions provided a significant increase in aerobic endurance, speed, power, and agility of youth basketball players.

Keywords: weight training, plyometrics, complex training, adolescent basketball players.

Introduction

Basketball is a highly dynamic sport with rapid speed changes and a lot of jumping, thus all of the muscles in the body play an active role (Aksovic et al., 2021). This sports scores to put the ball into the ring repeatedly to win the match, which necessitates strong physical aspects (Amaro et al., 2023). Basketball is a sport played by five persons on one team against each other which means that this sport involves physical contact (Deepika, 2021). The physical aspect becomes important when sports require fast, strong movements and physical contact (Yudhistira, Suherman, et al., 2021). Basketball, like other sports, is a sport that combines aerobic and anaerobic energy system activities such as metabolism, as well as intermittent and explosive movements (Freitas et al., 2019). These movements are characterized as jumping on one leg, jumping on two legs, running fast, and changing direction repeatedly over a relatively long duration (Freitas et al., 2019; Yudhistira & Tomoliyus, 2020). In this case, the foundation of basketball strength training is extremely important to offer optimal contributions to movements linked to running speed, agility, leg muscle power, and aerobic endurance (Freitas et al., 2019; Neal et al., 2018).

Sports training programs must be specifically designed to optimize athlete performance (Alvar et al., 2017; Hartono et al., 2024). As a result, training programming as provided in training methods is one of the keys to optimizing physical performance. A good training program improves numerous essential components of a sport (Saifu et al., 2021; Sulistiyono et al., 2021; Yulianto & Yudhistira, 2021). Aside from that, good training approaches have undoubtedly been used in prior studies with a consistent level of effectiveness

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(Purnawan et al., 2022; Yulianto & Yudhistira, 2021). The complex training method is an appropriate option for enhancing physical condition in basketball (Nikolic et al., 2017). One variation of the complex training method is a combination of plyometrics and weight training (Cavaco et al., 2014).

Several studies have highlighted the effectiveness of complex training methods, including a study by Freitas et al comparing optimal load vs modified complex training methods on dynamic upper and lower body strength, 10-meter speed, countermovement jump, standing long jump, and change of direction (Freitas et al., 2019). In this study, the effectiveness of complex training on vertical jump performance (Dan et al., 2014), and the short-term effects of complex training on agility performance of soccer players (Cavaco et al., 2014). Complex training exercises for ten weeks twice a week have a significant influence on the leg muscle power of basketball players (Dejan, 2012).

The effect of a constant resistance training complex versus a variable resistance training complex on physical performance (Shi et al., 2022), boosting physical performance with a complex training intervention for three weeks (Šebić et al., 2023), and improving sprinting with complex training methods in young basketball players (Nikolic et al., 2017). Several studies have shown that delivering interventions utilizing complex training methods has a positive effect on physical performance in sports games.

The author carefully examined the research listed above, which concentrated on improving power, maximum strength, and speed while not measuring aerobic endurance. Naturally, this raises the concern of whether complex training may improve aerobic endurance. Aside from that, the intervention was relatively short-term, with only three weeks of training and sixteen meetings. According to recent studies, the suggested duration of training to develop power using plyometrics is 8 to 12 weeks; anything less than that is not considered desirable (Kumar et al., 2023). Furthermore, past research did not include consecutive and periodic testing. The samples utilized in some of the research above were not controlled in a single mesh. When athletes are not controlled in one mesh, external influences can impact the outcomes of physical performance. In this case, the author considers that additional empirical studies are needed to investigate the impact of complex training on the physical performance of adolescent basketball players.

As material for rationalizing the problem, the author gives observational and interview evidence that the physical training methods that have been devised are being implemented successfully. However, the author argues that various factors are critical, such as the use of training dosages that are not optimal in terms of intensity and volume. For example, the use of strength exercises aimed at developing speed and strength does not meet the parameters of intensity. Of course, when they are not well organized, the results are less than optimal. Furthermore, movement characteristics are naturally used to calculate the intensity of plyometric training, and the number of foot contacts made during landing is used to calculate volume as a parameter for establishing the training dose (Pramono et al., 2023). However, in practice, this type of regulation is not followed. According to studies, the exercise dose is related to a drug dose: if given more than the dose, it will result in an overdose, and if given less, it will not affect the body (Gronwald et al., 2020; Maslov et al., 2018; Yudhistira, 2023). The same is true for physical training; if the training dose exceeds capacity and there is no recovery setting, overtraining will occur, but supplying a lower training dose will not result in training adaptation (Gronwald et al., 2020; Maslov et al., 2018). As a result, physical exercise must be carried out regularly, with an appropriate training load and the principle of individuality (Gronwald et al., 2020).

In this context, the author's goal is to cover the gap left by earlier studies by carrying out a more comprehensive study into the use of complex training methods to enhance the physical performance of adolescent basketball players. The purpose of this study is to determine the effectiveness of the complex training method increases running speed, leg muscle power, agility, and aerobic endurance. The author conducted three tests in this study. The first test is a pretest, which is completed before the intervention is administered. The second test takes place after the intervention has been running for 16 meetings, to assess progress and evaluate training. The final test, or the post-test, is administered after the intervention is completed or after 24 meetings. Testing is carried out separately from administering the intervention. The authors hypothesize that the complex training method will improve adolescent basketball players' aerobic endurance, running speed, leg muscle power, and agility. It is intended that this study will make a significant contribution by providing the most recent empirical data on the efficiency of complex training methods for adolescent basketball players.

Materials and Methods

Study Participants

This study is a field testing experiment using a one-group pretest-posttest design. The study included 16 adolescent basketball players from the Generasi Muda Cirebon Basketball Club in West Java, Indonesia, between the ages of 17 and 20, weighing between 60 and 80 kilograms and standing between ±170-190 centimeters tall. The collection of data techniques includes observations to identify phenomena in the training area, physical measurement tests, and document analysis in the form of articles in relevant journals as material for rationalizing problems. The sampling technique was purposive, with the following criteria: (1) basketball players who train at the Generasi Muda Cirebon Club, (2) male, (3) attending the Generasi Muda Cirebon Club daily, and (4) being in good health or not incurred an injury. Aerobic endurance, short running speed, agility, and leg muscular power are the physical aspects tested. The instruments used were the Multistage fitness test, 20-meter sprint acceleration, lane agility, and jump DF.

Study Organization

The authors conducted an observational study at the Generasi Muda Cirebon basketball club, with a thorough analysis focusing on the physical aspects. Several problems have been uncovered in various physical aspects that are significant in basketball matches. Aside from that, the author analyzed various journal-based articles that focused on experimental investigations with complex training program

Table 1. Complex training program

Week	Meeting	Exercise	Intensity	Rep/Jump	NC	NS	PC	PI	RS
1-4	1-8	WT	60-70% (1RM)	8-12 rep	4	4	30 s	0-10 s	3 min
		Plyo	Maximal	84-92 jumps					
5-8	9-16	WT	70-75% (1RM)	8-10 rep	4	4	30 s	0-10 s	3 min
		Plyo	Maximal	92-100 jumps					
9-12	17-24	WT	75-80% (1RM)	5-8 rep	4	4	30 s	0 -10 s	3 min
		Plyo	Maximal	100-112 jumps					

Description: WT-weight training, Plyo-Plyometrics, NC-Number of Complexes, NS-Number of Sets, PC-Pause between Complexes, PI-Pause between items, RS-Rest between Sets

interventions on team and game athletes to boost the authors' research. To make it clearer, the program is presented in Table 1 as follows:

The training program lasted 12 weeks with a total of 24 meetings. The frequency of training in one week is 2 times to optimize the recovery process. Complex training is conducted during the initial special preparation stage to prepare for matches against national clubs. This signifies that the previous stage, which included general preparation for training in areas such as maximum strength, hypertrophy, muscle endurance, and aerobic and anaerobic endurance, has been completed previously. As a result, this specific period serves as the conversion phase for power training. This training sequence lasts about 90 minutes and consists of three parts: dynamic static stretching (15 minutes), core complex training (60 minutes), and cool-down (15 minutes). One training complex consists of one weight training exercise item and one plyometrics exercise, administered with a 10- to 30-second break. In one weight training activity, there is a 0-10 second break followed by plyometric exercises. One series consists of completing four complexes, resulting in a three-minute break. The intensity of weight training exercises begins at 60% and gradually increases to 80%. The repetitions at 60% intensity are 10-12, 70%-75% are 8-10, and 80% are 5-8. Weight-training exercises include barbell squats, leg presses, leg extensions, leg curls, and standing barbell calf raises. The intensity of plyometric training is determined by the movements utilized; for example, bilateral movements in the ladder box are classified as low-level plyometrics, whereas jumping one leg from the ladder box is classified as intense plyometrics (Davies, 2015). In this case, the plyometrics used are high intensity plyometrics training items used are tuck jump, box jump, hurdle jump, reactive depth jump box, depth jump with sprint. In this case, the plyometrics are performed at a high intensity. Tuck jumps, box jumps, hurdle jumps, reactive depth jump boxes, and depth jumps with sprints are examples of plyometric training exercises used. In terms of determining the volume of plyometrics training in one session, if the number of jumps is 60, it is included in the low-volume category, and more than 200 jumps are included in the high-volume category (Chu & Myer, 2013).

Statistical Analysis

The training program was carried out in 24 meetings. The test was carried out three times. Before carrying out the training program, a pretest was carried out, after meeting 16 a second test was carried out, after meeting 24 a posttest was carried out. This means that by running these three tests, it will be discovered the comprehensive effectiveness of the programming of the training complex.

The data analysis technique employed was quantitative descriptive analysis, which presents minimum, maximum, mean, and standard deviation values. To compare the pretest and posttest results from the first, second, and third tests, an alternative nonparametric test using Friedman analysis from Anova was utilized, which was assisted by the SPSS version 23 application (Hadi & Yudhistira, 2023; Sulistiyono et al., 2021; Yudanto, Suherman, et al., 2022; Yudanto, Yudhistira, et al., 2022).

Results

Table 2. Results of data descriptions of endurance, speed, agility, and power

Variable	Min	Max	Mean	Std. Dev
Aerobic Endurance Test 1	47.01	57.04	48.53	3.29336
Aerobic Endurance Test 2	47.09	62.02	50.01	4.20972
Aerobic Endurance Test 3	49.01	63.01	52.47	4.37947
Speed Test 1	2.96	3.45	3.20	0.14098
Speed Test 2	2.96	3.42	3.18	0.12990
Speed Test 3	2.08	3.21	2.97	0.33097
Agility Test 1	11.31	12.26	11.66	0.25591
Agility Test 2	11.27	12.58	11.70	0.42556
Agility Test 3	10.09	11.41	10.57	0.43995
Leg Power Test 1	60	72	66	4.143
Leg Power Test 2	60	72	65	3.594
Leg Power Test 3	64	76	69	3.715

According to the results of the descriptive analysis presented in Table 2, the average score for the first endurance test is 48.53, the second is 50.01, and the third is 52.47. The average speed test score for the first is 3.20, the second is 3.18, and the third is 2.97. The first agility test yielded an average of 11.66, the second 11.70, and the third 10.57. The first leg muscle power test resulted in an average of 66, followed by 65 and 69. The mean values obtained from the first, second, and third tests for endurance, speed, agility, and leg muscular power showed a tendency to increase.

Table 3. Results of Friedman Test Analysis

Test	Mean Rank	Asymp.Sig	Information
Aerobic Endurance Test 1	1.00	0.000	Significant differences were found
Aerobic Endurance Test 2	2.00		
Aerobic Endurance Test 3	3.00		
Speed Test 1	2.88	0.000	Significant differences were found
Speed Test 2	2.09		
Speed Test 3	1.03		
Agility Test 1	2.47	0.000	Significant differences were found
Agility Test 2	2.53		
Agility Test 3	1.00		
Leg Power Test 1	1.56	0.000	Significant differences were found
Leg Power Test 2	1.44		
Leg Power Test 3	3.00		

Based on the results of Friedman's analysis presented in Table 3, the Asymp.sig scores for endurance, speed, agility, and power are all less than 0.05. As a result, it would be feasible to explain why the average increase varies between the three measurement interval groups. In other words, complex training programs can improve physical aspects such as endurance, speed, agility, and leg muscular power in adolescent basketball players.

Discussion

The Friedman analysis results show that the endurance aspect has an Asymp.sig value of 0.000<0.05, followed by speed, agility, and power at 0.000<0.05. These findings demonstrate that the average score in the physical aspects such as endurance, speed, agility, and leg power varies between the three measurement time interval groups. The key finding was that 24 meetings of complex training increased physical aspects such as endurance, speed, agility, and leg muscle power. If we look attentively, the physical aspects of the first, second, and third tests differ significantly. The first test in this study was a pretest. The second test, which involved intervention across 16 meetings, revealed a significant improvement, particularly in agility and leg muscular power. However, it does not end there; after 24 intervention meetings, these three physical aspects showed greater improvement than the second test. In other words, even in the second test, there was an improvement, but the rise could not be considered permanent. Previous studies revealed that intervention over 8 meetings can alter performance, either increasing or decreasing, whereas intervention over 16 meetings or more has a permanent change impact (Faizal et al., 2019; Yudhistira, 2023). In addition, the novelty of the study was obtained, namely the novelty of the measurement test method which previously only carried out pretests and postests in this study using three tests to see the improvement. Then previous studies focused on increasing power, but in this study the authors added an independent variable, namely endurance.

Basketball players require physical skills such as running movements to attack. Meanwhile, to survive fast, speed is required, which is associated with running. Furthermore, agility and leg muscular power are vital when running simultaneously while shooting and jumping into the ring or running past the opponent in front of him (Hadi et al., 2022). Aside from that, endurance is essential when performing these movements repeatedly. As a result, the role of physical conditioning in basketball is very complex (Hadi et al., 2022; Hidayah & Akhiruyanto, 2023) In this case, different complexity training is required to optimize the physical condition. This is, of course, extremely important for sports practitioners and academics; earlier research reported a large reduction in adolescent basketball players during the competition season, implying that complex training is an alternative method for enhancing good physical aspects (Freitas et al., 2019).

Complex training is a physical training method for basketball players that aims to optimize physical condition to the maximum extent feasible (Aksovic et al., 2021). Complex training is high-intensity exercise training that includes maximum strength and explosive strength training (Aksovic et al., 2021). Complex training is distinguished by weight training exercises that are subsequently channeled into plyometric exercises (Aksovic et al., 2021). Furthermore, from a biomechanical perspective, complex training exercises must be adjusted to include muscle and joint involvement between weight training and plyometrics exercises to achieve optimal results (Mansur, 2016). For example, we can do complex training exercises for the lower extremity muscles with squats for 3-6 repetitions, followed by plyometrics tuck jump exercises for 8-12 repetitions, and then complex training exercises for the upper extremities, such as bench press 2-5 repetitions followed by plyometrics push up for 8 repetition (Mansur, 2016).

Complex training affects physical performance in team and individual sports, including power, speed, and agility (Mansur, 2016). According to studies, variable-resistance complex training is as effective as standard complex training in developing power and sprint speed in rugby (Scott et al., 2023). Variable resistance complex training, in particular, increased relative strength more than traditional complex training, which increased 10 and 20-meter sprint speed. According to other studies, complex training improves sprint performance, making it one of the training options for game sports (Scott et al., 2023). A comparable study attempted to assess optimal load training methods with modified complex training in basketball players, and the results showed that both methods were equally effective in building lower-extremity strength and power (Freitas et al., 2019). In this situation, complex training significantly improves the vertical jumping capacity of adolescent basketball players (Dan et al., 2014). The enthusiasm of sports academics, particularly for improving the physical condition of basketball players, does not end here. This is supported by the most recent research on complex training methods that are modified in the form of speed, agility, and quickness training by monitoring individual training doses during the three-week intervention, which shows that there is an improvement in the physical condition of speed endurance, aerobic endurance, speed acceleration, agility, and leg muscle power (Šebić et al., 2023).

However, in this situation, the use of the complex method of training must be tailored to the training stages. Complex training focuses on strength and power training

using external loads, as well as power training employing plyometric training methods. This suggests that strength is essential for developing power, speed, and agility (Nasrulloh et al., 2023). Furthermore, basketball players can improve their aerobics endurance with complicated exercises. Of course, basketball players have previously completed general and anaerobic endurance training. In line with previous studies, the initial part of complex training is used as basic preparation, and development of general endurance and strength endurance so that basketball players are ready to practice complex training with high intensity (Nikolic et al., 2017).

Therefore, when a basketball player begins to train utilizing a complex training method, they must first establish a solid foundation, keeping in mind that strength training affects the optimization of gaining power. Trainers must pay particular focus to maximum strength data when determining the intensity of weight training exercises to be paired with plyometric training. The basic requirement for high-impact plyometrics training is that the athlete should meet some criteria, including the ability to perform a barbell back squat weighing 1.5 of the athlete's body weight (Pramono et al., 2023). In this study, all basketball players who received intervention with complex training met the criteria by completing maximum strength and aerobic endurance training in the previous stage. Thus, it can be concluded that giving a complex training program is a safe way to optimize the physique of young basketball players. But by paying attention to the periodization of exercise and the right dose of exercise.

Developing basketball players is more complicated than just twisting our hands. Coaches must comprehend the characteristics of individual athletes and teams. As a result, the coaching principle is how athletes can learn in all areas of education, both at and outside of school (Armour, 2013). According to the study, this is related to pedagogical principles, namely guidelines and procedures for learning sports-specific abilities (Lee et al., 2014). Furthermore, the most important rule is how to properly implement learning so that athletes benefit individually, as a team, socially, and in good health (Armour, 2013)

Conclusions

Mean scores varied between the first, second, and third tests in all physical aspects, including aerobic endurance, speed, power, and agility. The Asymp. sig (2-tailed) value for all aspects was $0.000 < 0.05$, indicating a significant difference. Based on the findings and discussion, it is possible to infer that the sequential complex training method used in the first, second, and third tests resulted in significant differences in aerobic endurance, speed, leg muscle power, and agility among adolescent basketball players. However, this study has limitations for its sample size which was only 16 male athletes, with no comparison group. It is thus expected that more studies could fill this research gap and generate more comprehensive results.

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Conflict of interest

All authors declare no conflict of interest.

References

Aksovic, N., Bjelica, B., Milanovic, F., Ljubica, M., & Jovanovic, N. (2021). Development of explosive power in basketball players. *Turkish Journal of Kinesiology, 7*(1), 44-52. https://doi.org/10.31459/turkjkin.861920

Amaro, C. M., Amaro, A. M., Gomes, B. B., Castro, M. A., & Mendes, R. (2023). Effects of Different Basketball Shooting Positions and Distances on Gaze Behavior and Shooting Accuracy. *Applied Sciences (Switzerland), 13*(5). https://doi.org/10.3390/app13052911

Deepika, V. (2021). A Study On The Co-Relation Of Basket Ball Playing Ability. *Turkish Online Journal of Qualitative Inquiry (TOJQI), 12*(6), 8759-8765.

Yudhistira, D., Suherman, W. S., Wiratama, A., Wijaya, U. K., Paryadi, P., Faruk, M., Hadi, H., Siregar, S., Jufrianis, J., & Pratama, K. W. (2021). Content Validity of the HIIT Training Program in Special Preparations to Improve the Dominant Biomotor Components of Kumite Athletes. *International Journal of Human Movement and Sports Sciences, 9*(5), 1051-1057. https://doi.org/10.13189/saj.2021.090527

Freitas, T. T., Calleja-González, J., Carlos-Vivas, J., Marín-Cascales, E., & Alcaraz, P. E. (2019). Short-term optimal load training vs a modified complex training in semi-professional basketball players. *Journal of Sports Sciences, 37*(4), 434-442. https://doi.org/10.1080/02640414.2018.1504618

Yudhistira, D., & Tomoliyus. (2020). Content validity of agility test in karate kumite category. *International Journal of Human Movement and Sports Sciences, 8*(5), 211-216. https://doi.org/10.13189/saj.2020.080508

Neal, W. E. N., Dalbo, V. J., Burgos, B., Pyne, D. B., & Scanlan, A. T. (2018). Power testing in basketball: Current practice and future recommendations. *Journal of Strength and Conditioning Research, 32*(9). https://doi.org/10.1519/jsc.0000000000002459

Alvar, B., Sel, K., & Deuster, A, P. (2017). *NSCA's essentials of tactical strength and conditioning.* In Human Kinetics.

Hartono, M., Akhiruyanto, A., Yudhistira, D., & Sulistiyono, S. (2024). Massed and Distributed Practice: What is the Best Method to Improve Young Dribbling Skills of Football Players? *International Journal of Human Movement and Sports Sciences, 12*(1), 18-25. https://doi.org/10.13189/saj.2024.120103

Saifu, Karakauki, M., Ali, S. K. S., Mustapha, A., Muslim, B. A., Ismiyati, F., Sundara, C., Wahyuni, S., Putri, D. T., Kristiyanto, A., Pratama, K. W., Nasrulloh, A., & Yudhistira, D. (2021). The effect of small game exercise on freestyle swimming speed: A case study of Halu Oleo university sport science student. *International Journal of Human Movement and Sports Sciences, 9*(6), 1140-1145. https://doi.org/10.13189/saj.2021.090609

Sulistiyono, S., Akhiruyanto, A., Primasoni, N., Arjuna, F., Santoso, N., & Yudhistira, D. (2021). The Effect of 10 Weeks Game Experience Learning (Gel) Based Training on Teamwork, Respect Attitude, Skill and Physical Ability in Young Football Players. *Physical Education Theory and Methodology, 21*(2), 173-179. https://doi.org/10.17309/tmfv.2021.2.11

Dwi Yulianto, W., Sumaryanti, & Yudhistira, D. (2021). Content Validity of Circuit Training Program and Its Effects on The Aerobic Endurance of Wheelchair Tennis Athletes. *International Journal of Kinesiology and Sports Science, 9*(3), 60. https://doi.org/10.7575/aiac.ijkss.v.9n.3p60

Purnawan, A. C., Yudhistira, D., Ode, L., Virama, A., Naviri, S., Semarang, U. N., Semarang, K., Training, T., & Education, P. (2022). The Effects of 1:1 Interval Ratio Training on Agility and Endurance of Young Football Players. *Asian Exercies and Sport Science Journal, 7*(1), 1-8. https://doi.org/10.30472/aesj.v7i1.352

Nikolic, D., Beric, D., Kocic, M., & Daskalovski, B. (2017). Complex Training and Sprint Abilities of Young Basketball Players. *Physical Education and Sport, 15*(December), 25-36. https://doi.org/10.22190/FUPES1701025N

Cavaco, B., Sousa, N., MacHado Dos Reis, V., Garrido, N., Saavedra, F., Mendes, R., & Vilaça-Alves, J. (2014). Short-term effects of complex training on agility with the ball, speed, efficiency of crossing and shooting in youth soccer players. *Journal of Human Kinetics, 43*(1), 105-112. https://doi.org/10.2478/hukin-2014-0095

Dan, R., Rick, L., & De, B. (2014). The Effects of a Complex Training Protocol on Vertical Jump Performance in Male High School Basketball Players. *Journal of Sport Science, 2*(September), 1-12.

Dejan, J. (2012). Influence of complex training on explosive power of knee extensor muscles of basketball juniors. *Exercise and Quality of Life, 4*(1), 43-52.

Shi, L., Lyons, M., Duncan, M., Chen, S., Chen, Z., Guo, W., & Han, D. (2022). Effects of Variable Resistance Training within Complex Training on Neuromuscular Adaptations in Collegiate Basketball Players. *Journal of Human Kinetics, 84*(1), 174-183. https://doi.org/10.2478/hukin-2022-0094

Šebić, L., Čaušević, D., Kovačević, E., Aljiji, A., Vrcić, M., & Simović, S. (2023). Effects of A 3-Week Modified Complex Training on Athletic Performance of Women's National Basketball Players. *International Journal of Physical Education, Fitness and Sports,* March, 29-36. https://doi.org/10.34256/ijpefs2314

Kumar, D., Dhull, S., Nara, K., & Kumar, P. (2023). Determining the optimal duration of plyometric training for enhancing vertical jump performance: a systematic review and meta-analysis. *Health, Sport, Rehabilitation, 9*(3), 118-133. https://doi.org/10.58962/HSR.2023.9.3.118-133

Pramono, H., Rahayu, T., & Yudhistira, D. (2023). The Effect of Plyometrics Exercise through Agility Ladder Drill on Improving Physical Abilities of 13–15-Year-Old Volleyball Players. *Physical Education Theory and Methodology, 23*(2), 199-206. https://doi.org/10.17309/tmfv.2023.2.07

Gronwald, T., Törpel, A., & Herold, F. (2020). Perspective of Dose and Response for Individualized Physical Exercise and Training Prescription. *Journal of Functional Morphology and Kinesiology, 5*(3), 48. https://doi.org/10.3390/jfmk5030048

Maslov, P. Z., Schulman, A., Lavie, C. J., & Narula, J. (2018). Personalized exercise dose prescription. *European Heart Journal, 39*(25), 2346-2355. https://doi.org/10.1093/eurheartj/ehx686

Yudhistira, D. (2023). *Development of a special preparation period physical training model to improve power, agility and endurance in senior kumite karateka (Doctor Disertation)*. In Program Doktor Fakultas Ilmu Keolahragaan dan Kesehatan, Universitas Negeri Yogyakarta.

Davies, G. (2015). Current concepts of plyometrics exercise. *The International Journal of Sports Physical Therapy, 10*(6), 760-786.

Chu, D., & Myer, G. (2013). *Plyometrics.* https://doi.org/10.5040/9781718225459

Hadi, & Yudhistira, D. (2023). High-intensity interval training method in karate athletes: Can it improve power, agility, and endurance in the Kumite category? *Journal Sport Area, 8*(1), 43-51. https://doi.org/10.25299/sportarea.2023.vol8(1).10656

Yudanto, Suherman, W. S., Nugroho, S., Guntur, & Yudhistira, D. (2022). The Effect of Games Experience Learning Model and Fundamental Movement Skills on Improving Soccer Playing Skills in Youth Soccer Players. *International Journal of Human Movement and Sports Sciences, 10*(4), 815-822. https://doi.org/10.13189/saj.2022.100422

Yudanto, Y., Yudhistira, D., Antoni, M. S., & Septian, M. (2022). The Effect of the Training Model and Balance on Students' Sepak Sila Skills on Sepak Takraw Extracurricular in First Middle School. *Physical Education Theory and Methodology, 22*(4), 485-492. https://doi.org/10.17309/tmfv.2022.4.05

Faizal, M., Ismail, M., & Kamarudin. (2019). Pengaruh Latihan Ladder Drill Terhadap Kecepatan Menggiring Bola Pada Tim Sepak Bola Garuda Towera Fc. *Concept and Communication, null*(23), 301-316.

Hadi, Yudhistira, D., Romadhoni, S., & Kurnianto, H. (2022). Analysis of Agility, Strength and Power Differences in Basketball Players in Relation to Age. *International Journal of Human Movement and Sports Sciences, 10*(4), 748-753. https://doi.org/10.13189/saj.2022.100415

Hidayah, T., Akhiruyanto, A., Yudhistira, D., & Kurnianto, H. (2023). The Effects of LTAD-Based Programming on Fundamental Skills and Physical Abilities of Basketball Players Aged 11-12 Years. *Physical Education Theory and Methodology, 23*(6), 909-917. https://doi.org/10.17309/tmfv.2023.6.13

Mansur, M. (2016). Pengaruh Complex Trainingmanipulation terhadap Peningkatan Power Otot Tungkaipada Mahasiswa Prodi Pko Fik Uny. *Jurnal Olahraga Prestasi, 12*(1), 115243. https://doi.org/10.21831/jorpres.v12i1.9493

Scott, D. J., Ditroilo, M., Orange, S. T., & Marshall, P. (2023). The Effect of Complex Training on Physical Performance in Rugby League Players. *International Journal of Sports Physiology and Performance, 18*(3), 240-247. https://doi.org/10.1123/ijspp.2021-0565

Nasrulloh, A., Sumaryanti, Nugroho, S., Yuniana, R., Nurhadi, F. I., Prastyawan, R. R., Yudhistira, D., & Elumalai,

G. (2023). Theraband Exercise Program: Effective To Improve the Muscle Fitness of the Elderly. *Sportske Nauke i Zdravlje, 13*(2), 215-224. https://doi.org/10.7251/SSH2302215N

Armour, K. (2013). *Sport Pedagogy An introduction for teaching and coaching.* In Sport Pedagogy. https://doi.org/10.4324/9781315847108

Lee, M. C. Y., Chow, J. Y., Komar, J., Tan, C. W. K., & Button, C. (2014). Nonlinear pedagogy: An effective approach to cater for individual differences in learning a sports skill. *PLoS ONE, 9*(8). https://doi.org/10.1371/journal.pone.0104744

Впровадження комплексного методу тренування: Вплив на показники витривалості, швидкості, сили та спритності баскетболістів підліткового віку

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 7 с., 3 табл., 37 джерел.

Мета дослідження. Метою цього дослідження було вивчити вплив ефективності комплексного тренування на показники аеробної витривалості, швидкості, сили та спритності у баскетболістів підліткового віку.

Матеріали та методи. У дослідженні застосовано метод польового експериментального спостереження. Була проведена цілеспрямована вибірка, учасники якої відповідали наступним критеріям: (1) баскетболісти, які тренувалися в одному клубі, (2) чоловічої статі, (3) проводили щоденні тренування в одному клубі, (4) мали добрий стан здоров'я. Загалом було залучено 16 учасників з масою тіла 60-80 кг і зростом 170-190 см. Для отримання необхідного матеріалу використовувалися методики збору даних спостережень, огляд відповідних статей і тести. З метою забезпечення оцінки фізичних аспектів були застосовані наступні тести та інструменти: цифровий вимірювач, що розраховує висоту вертикального стрибка, човниковий біг, спринтерський біг на 20 метрів, тест на спритність на доріжці. Методика аналізу даних за критерієм Фрідмана була проведена шляхом застосування статистичного програмного забезпечення SPSS 23.

Результати. Середній бал першого тесту на витривалість склав 48,53, другий і третій тести продемонстрували результати 50,01 і 52,47, відповідно. Аналогічним чином, середній бал за перший тест на швидкість становив 3,20, другий був на рівні 3,18, а третій – 2,97. Середній бал першого тесту на спритність склав 11,66, другого показав 11,70, а третього – 10,57. Середній бал першого тесту на визначення сили м'язів нижніх кінцівок склав 66, а другого і третього тестів – 65 і 69, відповідно. Для визначення відмінностей в показниках аеробної витривалості, швидкості, потужності та спритності використовували змінні критерію Фрідмана, загальний рівень значущості становив 0,000<0,05.

Висновки. Впровадження комплексної методики тренування протягом 24 тренувальних сесій забезпечило значне підвищення показників аеробної витривалості, швидкості, сили та спритності юних баскетболістів.

Ключові слова: силове тренування, пліометрика, комплексне тренування, баскетболісти підліткового віку.

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