

Use of specialized 3×3 basketball exercises to improve the physical condition of basketball players

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Abstract.

Improving the physical condition of basketball players across all skill levels remains a relevant topic today. The continuous increase in game speed, coupled with the rising mass and height of athletes, along with their high maneuverability and technical skills, demands a higher level of physical fitness from basketball players. This study assessed the impact of 3×3 basketball training and competition on the physical fitness of young basketball players during the preparatory period of their annual training cycle. **Materials and methods.** The study involved twenty-four basketball players, aged 15-16 (I-II sports categories), who were part of specialized training groups. To assess the development of physical abilities, the following tests were administered: 20-m sprint from a standing start (s), 3×10-m shuttle run (s), vertical jump (cm), and YOYO IRT Level 1. During the preparatory period of the annual training cycle, athletes in the experimental group (EG) trained in 3×3 basketball and participated in competitions, including both city and national tournaments. After the first phase of the preparatory period, EG athletes shifted their focus to 5×5 basketball technical and tactical skills. Athletes in the control group (CG) followed a traditional annual training cycle. Statistical analysis was performed using Statistica software. The Shapiro-Wilk test was used to check for normality of the data. Descriptive statistics (mean (M), standard deviation (SD), standard error of the mean (m)) were calculated for each dependent variable. The paired samples Students t-test was used to assess the significance of differences in a single variable before and after the experiment, assuming normal distribution. The Wilcoxon signed-rank test (T) was used when the data did not meet the normality assumption. The Mann-Whitney U test was used to compare differences between two independent samples in different tests.

Results. The results of the "20-meter sprint from a standing start" test showed a significant improvement both in the experimental group (8.2%) and the control group (5.5%) ($p < 0.05$) compared to their pre-experiment results. When comparing the post-experiment test results of the CG and EG, no significant difference was found ($p > 0.05$). The improvement in the test results of the control group was 10.9% and of the experimental group - 10.5%, and was statistically significant ($p < 0.05$) compared to their initial results at the beginning of the study. When comparing the post-experiment test results of the CG and EG, no significant difference was found ($p > 0.05$). Changes in the results of the "Vertical jump" test revealed a more pronounced positive impact of specialized training and 3x3 competitions on the speed-strength abilities of the players. Thus, in the control and experimental groups after the experiment, significant improvements in results were found at 8.5% ($p < 0.05$) and 11.8% ($p < 0.01$), respectively. When comparing the post-experiment test results of the CG and EG, a significant difference was found at the $p < 0.05$ level. A similar trend was found in the change in the results of YOYO IRT Level 1. **Conclusions.** The positive impact of the use of 3x3 basketball equipment and the participation of athletes in competitions within the framework of the general preparatory stage of the preparatory period of the annual training cycle of classic basketball players on the indicators of their speed-strength abilities and special physical fitness was established.

Keywords: preparation, basketball 3x3, physical condition, training process, players.

Introduction.

The question of improving the physical fitness of basketball players of all skill levels remains relevant today. The constant increase in the speed of the game, the increase in the mass and height of athletes, combined with their high maneuverability and technical skills, place increased demands on the level of physical fitness of basketball players. Wenlong Li points out the need for new training methods to improve basketball players and help them reach a higher level of performance in contemporary basketball. Traditional methods are no longer adequate to address the evolving challenges of the sport, according to the author. Li also emphasizes the importance of continuous monitoring of the quality of player development and the timely adjustment of training loads based on the results.

Komotska, O., and Sushko, R., in their study, highlighted the positive impact of a 21-session training program on the preparation of young female basketball players as an integral part of their training for official national competitions. The authors propose using a relatively small volume of exercises, emphasizing the nuances of exercise execution, as well as adjusting the speed and duration of these exercises.

The traditional approach to training basketball players in China avoids imposing significant strength training loads on young athletes to prevent injuries that may occur due to fatigue and overtraining, as noted by

Yeji Su, Qingyun Zhong, and Min Liu. Therefore, there is a growing interest among practitioners in the scientific search for safe ways to improve the physical fitness of young basketball players. Luo S, Soh KG, and their co-authors, in their research on the fundamental physical preparation of basketball players, highlight the insufficiency of scientific data regarding the specific characteristics of basic training in terms of flexibility, endurance, and specific defensive functions in basketball players. Therefore, the authors recognize a significant correlation between physical fitness and the execution of specific technical and tactical skills during gameplay. These skills involve rapid changes in direction, speed-strength abilities, and coordinated movements maintained over extended periods without diminished effectiveness.

Morten B. in their study highlighted the positive impact of three months of training in 3x3 basketball, and a variation of it adapted for two baskets, on the physical fitness of men who had been physically inactive for the past year. The authors also noted improvements in various physical health indicators of the participants.

Herrán, A., Usabiaga, O., and Castellano, J., when examining the differences between basketball and 3x3, emphasize that the smaller number of players on a team encourages athletes to perform more active actions and counteractions on the court, which in turn increases the demands on athletes' functional capacities.

Paul G. Montgomery and Brendan D. Maloney point out that 3x3 basketball involves frequent rapid movements with acceleration, deceleration, changes in direction, and jumping. These attributes necessitate comprehensive training in strength, speed, and agility, combined with shooting and passing skills, to optimize performance. Similar results were described in our previous work (Musiienko et al., 2024) and in the work of other authors (Petrov & Bonev, 2018). The inertial characteristics of 3x3 result in low perceptual error in distance estimation and induce moderate to high physiological responses.

Building upon our previous findings (Musienko et al, 2023, 2024, 2025) which demonstrated a positive correlation between improved tactical interactions and enhanced physical fitness in 3x3 basketball players after a 3-month specialized training program, we hypothesized that 3x3 basketball training, characterized by a smaller court, increased situational changes (Epure, M. & Bondoc, D., 2019), contact, and a limited number of players, would likely lead to improvements in players' physical fitness indicators. The recommendations outlined by Paul G. Montgomery and Brendan D. Maloney were considered in developing our experimental training program for basketball players using 3x3.

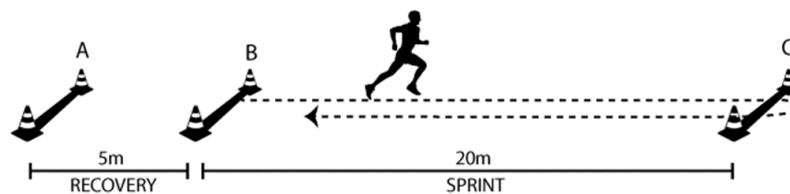
The objective of this study was to examine the impact of 3x3 basketball training and competition on the physical fitness of young basketball players during the preparatory period of the annual training cycle.

Materials and methods.

Twenty-four basketball players aged 15-16 (I-II sports categories) participating in specialized training groups were involved in the study. Prior to inclusion in the study, informed consent was obtained from participants who met the selection criteria. All participants volunteered to participate in the study and were assured that their data would be treated confidentially.

Pedagogical testing. To assess the development of basketball players' physical abilities, the following tests were used: 20-meter sprint from a standing start (s), 3x10-meter shuttle run (s), vertical jump (cm), and YOYO IRT Level 1.

The YOYO IRT Level 1 (YYIR1) test was developed to measure an athlete's ability to repeatedly perform high-intensity aerobic work (Jens, Marcello, & Krstrup, 2008). It is a simple method for assessing an athlete's capacity to perform repeated high-intensity aerobic exercises. The test was conducted in a stable indoor environment, protected from weather conditions, and on a reliable surface unaffected by wet or slippery conditions (Figure 1).



Yo-Yo Intermittent Recovery Test

www.theyoyotest.com

Fig. 1. Test track diagram YOYO IRT Level 1

The 20-meter distance of the shuttle run is covered in time with an audio signal. After each 40-meter run, there is a 10-second active recovery in a 5-meter recovery zone (back and forth). A prerequisite for passing the test is the participants' preparedness, familiarity with the testing procedure, and motivation for maximum performance. At regular intervals, the running speed gradually increases from 8.0 km/h to 13 km/h. The test is completed when the athlete decides to reach their physical limit or in the event of a second violation for falling behind the required running pace. The total distance covered by the athlete is calculated as a result.

The Yo-Yo Intermittent Recovery Test (Yo-Yo IRT) Level 1 application is a tool designed to conduct the Yo-Yo Intermittent Recovery Test; a fitness assessment commonly used to measure an athlete's endurance. This test is particularly popular in team sports and other activities requiring high levels of aerobic and anaerobic fitness. Using the YYIR1 norm table (Figure 2), a physical fitness rating is calculated (Bangsbo, Marcello Iaia, & Krstrup, 2008; Wood, 2018). Coaches often use the results of this test in conjunction with other assessments (such as sprint tests, agility tests, and skill evaluations) to gain a comprehensive understanding of a player's physical fitness and skill level.

Yo-Yo Intermittent Recovery Level 1					
Speed Level	Shuttles at Level	Speed (km/h)	Seconds at Level	Running Time	Running Distance
5	2	10.0	14.4	00:24	40
9	2	12.0	12.0	00:46	80
11	4	13.0	22.2	01:29	160
12	6	13.5	32.0	02:31	280
13	8	14.0	41.1	03:52	440
14	16	14.5	79.4	06:31	760
15	16	15.0	76.8	09:08	1080
16	16	15.5	74.3	11:42	1400
17	16	16.0	72.0	14:14	1720
18	16	16.5	69.8	16:44	2040
19	16	17.0	67.8	19:12	2360
20	16	17.5	65.8	21:38	2680
21	16	18.0	64.0	24:02	3000
22	16	18.5	62.3	26:24	3320
23	16	19.0	60.6	28:45	3640

Fig. 2. Normative table YYIR1

There are general criteria for Yo-Yo IRT Level 1 test results (for 15-16-year-old players, the norm is a distance of 1520 to 2000 meters), but it is important to interpret these results in the context of the athlete's overall development, training history, and the specific demands of basketball. Participants were divided into groups that were tested for homogeneity in terms of the physical fitness of athletes in the EG group, n=12, and the CG group, n=12.

Pedagogical Experiment. Athletes in the experimental group (EG) underwent a specific training regimen during the general preparatory phase of the pre-season, focusing on 3x3 basketball competitions. They participated in both local and national 3x3 tournaments. The training program for 3x3 competitions combined off-court and on-court sessions aimed at developing cohesive and effective teamwork. The program included components designed to enhance group interactions, game skills, and teamwork. Specific program elements included: theoretical sessions (visualization of model game strategies in 3x3 basketball, video analysis of tactical interactions in offense and defense by leading 3x3 teams), and tactical training sessions (specific tactical drills and training tasks reflecting the holistic nature of 3x3 basketball gameplay) within the allocated time for tactical training.

Proposed game-like training drills were designed to teach and improve offensive tactical interactions in 3x3 basketball. These drills relied on various types of screens and offered multiple options for tactical decision-making in their execution. The drills aimed to develop a generalized orienting basis for typical group tactical interactions, combining the improvement of group tactical actions and interactions both in offense and defense simultaneously. By adjusting the actions of defenders, it was possible to complicate game situations, increase their number, and enable the use of a wider range of interactions and variations. The training drills were created using the Basketball Playbook software and presented schematically on an animated screen, allowing for the creation of game sequences and the observation of their playback (Figs. 3-5).



Fig 3. Combination of actions Back screen 1

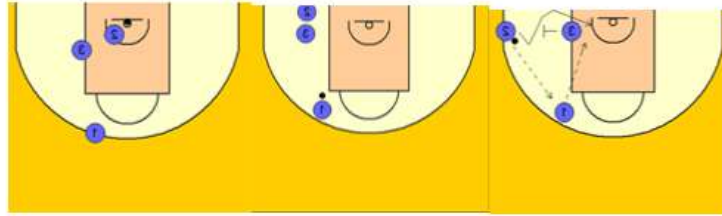


Fig 4. Combination of actions Back screen 2



Fig 5. Combination of actions Scissors 1

For the 3x3 competition, two teams were formed from the athletes in the experimental group (EG). Players were selected by the coach, considering their desire, fitness level, injury status, and the suitability of their positions in classic basketball (guard (1-2), forward (1-2), small forward). After the first stage of the preparatory period, the EG basketball players continued their preparation for the competitive season with a focus on technical and tactical training for 5x5 basketball. Athletes in the control group (CG) followed a traditional annual training cycle: special physical training camps and technical and tactical training for 5x5 basketball, using training methods specific to 5x5 basketball. There was no difference in the total training volume between the EG and CG groups, and the duration of the preparatory period in the annual cycle was the same for both groups and amounted to 2 months.

Ethical policy. This research included humans and therefore has been provided according to principles embodied in the Helsinki Declaration. The studies were approved by the Ethics Committee of H. S. Skovoroda Kharkiv National Pedagogical University.

Statistical analysis. Data analysis was conducted using the Statistica software package. The Shapiro-Wilk test was used to assess the normality of the data. Descriptive statistics (group means (M), standard deviations (SD), and standard errors of the mean (m)) were calculated for each dependent variable. A Student's t-test was used to evaluate the significance of differences in a single variable before and after the experiment, assuming a normal distribution. The Wilcoxon signed-rank test (Z-test) was used when the data of two related samples did not follow a normal distribution. For the comparative analysis of differences between the results of two independent samples in different tests, the Mann-Whitney U test was used.

Results of the research.

To determine the impact of the developed program on players' physical fitness, testing was conducted at the beginning and end of the pedagogical experiment. The results of the general and specific physical fitness tests for both groups indicate certain changes (Table 1).

Table 1 The dynamics of changes in basketball players' physical fitness outcomes under the influence of specialized basketball 3x3 exercises (EG (n=12), KG (n=12))

Test (measurement unit)	Research period	Group	M	SD	BE and AE	KG - EG AE
					Significance level	
20-meter sprint from a standing start (s)	BE	KG	3.10	0.20	t = 2.15*	t = 1.81
	AE		2.93	0.15		
	BE	EG	3.05	0.24	t = 2.68*	
	AE		2.80	0.17		
3x10-meter shuttle run (s)	BE	KG	6.10	0.90	t = 2.07*	t = 1.18
	AE		5.43	0.48		
	BE	EG	6.35	0.71	t = 2.50*	
	AE		5.68	0.46		
Standing vertical jump (cm)	BE	KG	48.81	5.49	t = 2.07*	t = 2.07*
	AE		52.99	3.26		
	BE	EG	49.98	3.06	t = 4.37**	
	AE		55.89	2.98		

YOYO IRT Level 1	VO ₂ Max (l/min)	BE	KG	49,58	2,14	T = 25	U = 32.5*
		AE		49,57	2,13		
		BE	EG	49.95	2.53	T = 3**	
		AE		52.34	1.18		
	distance (m)	BE	KG	1566.67	256.81	T = 25	U = 41*
		AE		1480.83	256.78		
		BE	EG	1611.66	302.37	T = 5**	
		AE		1723.33	355.51		
	Speed (km/h)	BE	KG	16,04	0,43	T = 20	U = 57
		AE		16,08	0,53		
		BE	EG	16.00	0.54	T = 5**	
		AE		16.29	0.65		

*p<0.05

**p<0.01

The results of the 20-meter sprint test significantly improved both in the experimental group (8.2%) and the control group (5.5%) (p<0.05) compared to their pre-experiment results, indicating the positive impact of the training methods chosen by the coaches on the basketball players' speed. No significant difference (p>0.05) was found between the experimental and control groups in the post-experiment test results.

The results of the 3x10m shuttle run test showed a similar trend towards improvement in speed and coordination in both groups. The improvement in performance in the control group was 10.9% and in the experimental group 10.5% and was statistically significant (p<0.05) compared to their initial results at the beginning of the study. When comparing the test results of the control and experimental groups after the experiment, no significant difference was found (p>0.05).

Changes in the results of the vertical jump test revealed a more pronounced positive impact of specialized training and 3x3 format competitions on the speed-strength abilities of the players. Thus, in the athletes of the control and experimental groups after the experiment, significant improvements in results were established at 8.5% (p<0.05) and 11.8% (p<0.01), respectively. When comparing the test results of the control and experimental groups after the experiment, a significant difference was found at the level of p<0.05.

Based on the YYIR1 test results, which measure the ability to perform repeated bouts of high-intensity aerobic work, the experimental group showed significant improvements in VO₂max, distance covered, and running speed (p<0.05). In contrast, the control group did not demonstrate significant improvements in VO₂max (p>0.05), nor in distance covered or running speed. A comparison of the test results between the control and experimental groups after the experiment revealed a significant positive impact of using 3x3 methods and participating in competitions of this type during the preparatory period of the annual training cycle on the ability of classic basketball players to perform high-intensity, prolonged aerobic work (p<0.05).

Discussion. The aim of this study was to examine the impact of specialized 3x3 basketball exercises on improving the physical fitness of basketball players. The results demonstrated their positive influence and a more significant improvement in speed-strength abilities and the players' ability to perform repeated high-intensity efforts compared to traditional methods of developing physical qualities in basketball players.

According to Cabarkapa et al., 2023, skill in 3x3 basketball has a more pronounced impact on game performance than the players' anthropometric characteristics. Given this, 3x3 players must perform almost identical technical and tactical actions during the game without the distribution of players by playing position, which in turn places certain demands on the physical fitness of all athletes. In their work, Huang Zhenting et al., 2024; Ferioli et al., 2022, have detailed the technical and tactical actions performed by 3x3 players during the game and the features of their application to gain an advantage over the opponent. In our study, we took these as a basis and confirmed that the use of 3x3 methods and participation in 3x3 competitions has a more significant positive impact on the physical fitness of basketball players compared to classical approaches in physical training (p<0.05), while not overloading them, which is also important in preparing a team for competitions (Su et al., 2023).

Tactics involve the rational use of individual players' skills and abilities through the organization of interactions among basketball players on the court and represent a way of collective actions of players (Ashford et al., 2021; Willberg et al., 2022). Its goal is to better utilize the skills and strengths of players on one team, limit the opponents' players, and strive to seize the initiative in the game. In the 3x3 game variant, the technical and tactical actions of players take on new meanings, as a smaller number of players on the court encourages basketball players to constantly interact to achieve a result. The rational use of tactics, based on the physical abilities of athletes, allows for a better organization of the players' advantage (Zhenting et al., 2024).

The magnitude and direction of the immediate training effect of special exercises in basketball depend on the combination of the effects of¹ all the main indicators of physical activity - the type of exercises used, their intensity and² duration, rest duration, and number of repetitions (Koryahin et al., 2020). Our research results, which used technical and tactical and physical training methods for 3x3 basketball players, indirectly confirm this. The use of such methods in combination with a competitive method of improving skills and developing

physical abilities, which we used in our study, had a positive impact on the manifestation of speed-strength abilities of basketball players and their ability to perform repeated high-intensity aerobic loads, the high development of which has a direct impact on the game outcome.

The simultaneous improvement in both 20-meter sprint and shuttle run performance in both groups of athletes was expected, as there is a strong correlation between these types of tests (Scanlan et al., 2021, Mikołajec et al., 2022).

The results obtained in our study, indicating a more significant improvement in the speed-strength endurance of basketball players in the experimental group ($p < 0.05$), are confirmed by the research of Zamzami et al., 2020, in which the authors note that the use of various types of basketball with a reduced number of players has a positive impact on the development of athletes' aerobic performance.

The positive effects of implementing small-sided games in athlete training, as highlighted in our study, have also been reported by Paprancova et al, 2024. Through their research focused on enhancing football player development, these authors demonstrated the efficacy of small-sided games in improving athletes' physical attributes.

Conclusions.

The search for means and methods to improve the training process of basketball players remains relevant. Given the young age of the players, one of the important tasks for coaches is to provide the necessary load of a specific orientation for the team and to prevent overtraining and injuries of athletes. 3x3 basketball tools with participation in a limited number of competitions have significant prospects in this direction. The game takes place on a smaller court relative to basketball and with a smaller number of participants, which encourages players to more movement, contact with the opponent and rapid adoption of game decisions while avoiding overloads of athletes. The competitive season in 3x3 basketball is quite short, which also allows to monitor the condition and fatigue of basketball players.

It has been established that the use of 3x3 basketball tools and the participation of athletes in competitions of this type within the general preparatory stage of the annual training cycle for classic basketball players has a positive impact on their speed-strength abilities and special physical fitness. Thus, significant improvements occurred in athletes in the indicators of vertical jumps from the spot and all indicators of the yo-yo test: VO2Max (l/min), distance (m) and Speed (km/h).

The results obtained allow us to recommend the participation of basketball players in competitions in the 3x3 format in the preparatory period of the annual training cycle, if the tasks of the training process at this stage by the coach was determined to increase the speed-strength abilities and special endurance of athletes.

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Conflict of interests. The authors note that there is no conflict of interests.

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