Peculiarities of Physical Fitness of 17-20 Years Old Basketball Players Taking into Account Their Playing Role

Mykola Bezmylov[1], Oksana Shynkaruk[1], Grygoriy Griban[2,*], Bogdan Semeniv[3], Oksana Yudenko[4], Andrii Lytvynenko[5], Olena Otroshko[6], Nataliya Kholchenkova[7], Halyna Kurtova[8], Mykola Kostenko[6], Alimie Osmanova[9]

[1]Department of Esports and Information Technologies, National University of Ukraine on Physical Education and Sport, Kyiv, Ukraine
[2]Department of Physical Education and Sport Improvement, Zhytomyr Ivan Franko State University, Zhytomyr, Ukraine
[3]Department of Physical Education, Sports and Health, Stepan Gzhytskyi National University of Veterinary Medicine and Biotechnologies Lviv, Lviv, Ukraine
[4]Department of Theory, Methodology and Organization of Physical Training and Sports, The National Defense University of Ukraine named after Ivan Cherniakhovskyi, Kyiv, Ukraine
[5]Department of Physical Education, Kharkiv National University of Radio Electronics, Kharkiv, Ukraine
[6]Department of Physical Education, National University of Life and Environmental Sciences of Ukraine, Kyiv, Ukraine
[7]Department of Physical Education and Choreography, T.H. Shevchenko National University "Chernihiv Colehium", Chernihiv, Ukraine
[8]Department of Sports, T.H. Shevchenko National University "Chernihiv Colehium", Chernihiv, Ukraine
[9]Department of Psychology, Open International University of Human Development "Ukraine", Kyiv, Ukraine
*Corresponding Author: gribang@ukr.net

Abstract The article examines the problems of controlling the physical fitness of basketball players who are at the training stage for higher achievements. The comparative analysis of the level of physical fitness of young Ukrainian basketball players and their foreign peers who underwent testing (Draft Combine) during selection for professional NBA clubs was carried out. A significant ($p < 0.05$) advantage of foreign basketball players in tests that determined the level of speed, speed and strength as well as coordination abilities over Ukrainian basketball players was established. The players of the defending line (point guard, shooting guard) have a reliable advantage over the players of the offensive line (forward, center) in such tests as ¾ court sprint, line agility test, vertical jump, Yo-Yo test. Statistically reliable correlative relationships were established between the results of the multi-stage Yo-Yo shuttle test and the parameters of competitive activities of basketball players in a match. The athletes who showed better results in the Yo-Yo test (m) spent more playing time on the court during the season (r = 0.722).

Keywords Physical Fitness, Sports Selection, Competitive Activities, Basketball Players, Playing Role

1. Introduction

A special place in the system of selection and orientation, as a promising direction for improving the training of

athletes, belongs to the selection of players for high-class teams. The sports result in those sports, where the final result is achieved by the joint efforts of team partners, directly depends on the effectiveness of the team selection process. Along with the individual capabilities of the players, selection into the team is also influenced by the chosen tactical version of the game, the peculiarities of the team's technique and tactics of the opponent, etc. The ability of each player to realistically assess his / her capabilities and the capabilities of his / her partners, to subordinate the desire to achieve personal success to the interests of the team is also important [1,2].

During the selection of the team, it is necessary to focus on the extent to which the capabilities of individual players correspond to their playing role in the team, the nature of the game functions assigned to them [3,4].

Selection of basketball players for a top caliber team is a complex and multi-stage process. A sports team in competitive sports is a unique combination of athletes of different ages and roles, level of technical and tactical degree of training, individual psychological capabilities, etc.

At the same time, the selection of young players who do not yet have the experience of performing in high-level sports and claim to be part of top caliber teams is one of the most difficult issues from a methodological and organizational point of view. This stage covers the age period from 17 to 20 years in many team competitive sports [5-7].

The stage of preparation for achieving the highest sportsmanship in basketball is the link that ensures a smooth transition of players from the children's and youth system to adult sports. The demands on the individual capabilities of the players also increase along with the increase in training and competition loads. Athletes have to constantly fight for a place in the team. One of the problems at this stage of training basketball players is the still unfinished process of choosing game specialization. Basketball players continue to develop their abilities, their total physical dimensions and a number of other indicators change that can affect the final choice of playing role in the team [8-10].

Unlike experienced players, the result shown at sports competitions for young players (in youth sports) is not yet the universal criterion that allows you to make an unerring choice in favor of one of the applicants for a place in the team. When determining the prospects of a young player, it is necessary to take into account a wide range of factors and indicators, which in the future can affect the growth of sportsmanship and successful multi-year performances in sports of higher achievements [11,12].

One of the important problems today in the theory and practice of basketball is the justification and creation of a general algorithm for the organization of selection and systematization of informative criteria for determining the promising opportunities of basketball players at the stage of preparation for higher sporting achievements.

In the process of selecting basketball players at the stage of preparation for higher sporting achievements, it is important to take into account the level of their general and special physical fitness. Today, the world's leading basketball clubs use unified pedagogical tests that allow you to determine the level of manifestation of the motor qualities most significant for basketball (speed and strength, speed, coordination abilities and the level of general and special endurance, etc.) [2,13].

1.1. The aim

The aim of the research is to carry out a comparative analysis of the level of physical fitness of 17-20 years old Ukrainian and foreign basketball players, taking into account the playing role and to establish their relationship with the effectiveness of the athletes' competitive activities.

2. Materials and Methods

2.1. Research Participants

The research involved 29 players of the U 18 and U 20 youth basketball teams of Ukraine, as well as basketball players of the "Kyiv-Basket" team, who played in the youth club championship of Ukraine. For the comparative analysis, the data from the official NBA website (https://www.nba.com/stats/draft/combine/) were used, which presents statistical data on the results of the tests of 75 basketball players i. e. participants of the Draft Combine from 2010 to 2021, who conformed with the age, role and average morphological data. The previous studies [14] established the morphofunctional characteristics of 200 young basketball players competing in European championships (Spain, France, Lithuania, Serbia, Ukraine). It was determined that athletes differed in weight and body length according to their playing role. Basketball players in the "Center" position have the largest body weight, and the "Point guard" – the smallest. The "Point guard" position players have the shortest, and the "Center" – the longest body length. Accordingly, the role of athletes was taken into account when performing tests to assess their physical fitness.

The basketball players of youth Ukrainian teams who participated in our research passed a series of tests at the beginning of the playing season (October) in a sequence that corresponds to Draft Combine. Each of the athletes participated, on average, in eight to twelve games of the championship and the country's cup. The players' functional degree of training was expected at a submaximal or maximal individual level (the testing was conducted on the third day after the game). When using pedagogical tests, in order to determine the level of physical fitness, it is important to take into account the stage of training within

the annual cycle and the state of "sports fitness" of the team and the athlete.

2.2. Research Methods

The following tests were used to determine the level of physical fitness of basketball players: 22.86 m running (3/4 court sprint), vertical jump; test to determine the coordination abilities of athletes (Lane agility test), Yo-Yo test. This group of tests is part of the mandatory testing program for NBA candidates during the Draft Combine. Athletes were tested in the afternoon (evening training).

The studies of jump height were carried out at the research institute of the National University of Physical Education and Sports of Ukraine using the Qualisys video computer complex, equipped with 7 high-frequency cameras, markers, a strain-gage platform and software. To determine the kinematic and dynamic characteristics of the jump, a special marker was attached to the athletes at the level of the general center of mass. The athlete made several attempts of vertical jumps. The most successful jump attempt was saved. Landing after the jump was carried out on the strain-gage platform. The indicators of the jump height (h, cm), absolute and relative force of dislodging (F, N; F\kg, N\kg) were determined.

22.86 m running (3/4 court sprint) is a test in the NBA for evaluating the speed capabilities of candidates during the annual draft procedure (selection of players to NBA clubs). The players performed maximum acceleration along the basketball court to the opposite charity stripe. Chips, which marked the places of the start and end of the run, were installed on the front and opposite free throw lines. At the signal, the athletes had to cover the specified distance at maximum speed. The stopwatch was started after the acoustical signal and it was stopped after crossing the charity stripe.

During the Line agility drill coordination ability test, basketball players moved at maximum speed around the lane in the following sequence: 1) running forward from the edge of the charity stripe to the baseline; 2) moving with a sidestep to the right from the left edge of the lane on the baseline to the right edge of the border of the lane on the baseline; 3) running backwards from the right edge of the lane line to the free throw line; 4) moving with a sidestep from the right to the left edge of the free throw line, then back to the starting point in a mirror sequence. The exercise was performed at maximum speed. The athletes were given several attempts. During the test, control was carried out to ensure that the athletes did not shorten the distance due to cutting "corners" and correctly performed various types of movement (backward running, sidestep). The test started and ended after the acoustical signal. The result was recorded using a stopwatch.

The shuttle Yo-Yo test Recovery Level 1 (RL1) was used to determine the level of endurance. A distance of twenty meters was marked on the court; another five meters were set for recovery after the completed the segment. The Yo-Yo test in our research was simultaneously performed by seven basketball players who had approximately the same anthropometric data and performed similar game functions on the court (forward line–forwards and centers, defending line–back-court players). To perform the test, a licensed program (Yo-Yo Intermittent Pro 2.32) was used, which allowed us to set the running speed, record the total time and distance covered, and count the seconds for rest in the pauses between forty-meter segments. The power of the acoustical signals was adjusted using the audio system.

The effectiveness of the competitive activities of basketball players was carried out on the basis of the analysis of the International Basketball Federation (FIBA) game protocols, which reflected the standard technical and tactical actions recorded during the match (points, 1,2,3 shots, assist, turnovers, steals, rebounds, foul, EFF etc.). Testing was carried out during the 2020-2021 playing season in the process of the preparatory and competitive periods for three times.

Testing of functional capabilities was carried out at the beginning of the game season (October) before testing of physical fitness. The response of basketball players' cardiorespiratory system to aerobic and anaerobic exercise was studied in standardized laboratory conditions, using such methods as ergometry, chronometry, spirometry, gas analysis, and pulsometry. The ergospirometry complex "Oxycon Pro" (Jaeger, Germany) was used for gas analysis. Devices were calibrated automatically before and after testing each athlete. Test loads were performed on the LE-200 treadmill according to the standard program. Heart rate (HR, beats.min^{-1}) was measured using the "Sport Test Polar" RS 800 (Finland). The anaerobic threshold was determined in the conditions of incrementally increasing exercise intensity in a non-invasive way. We determined such indicators as VO$_2$ max (ml.kg^{-1}.min^{-1}), maximum voluntary ventilation (MVV; l.min^{-1}), vital lung capacity (VLC; l), peak expiratory flow (PEF; l·s^{-1}), load intensity (W; Wt).

2.3. Statistical Analysis

Statistical analysis included checking the observed data for compliance with the normal law of distribution according to the Shapiro-Wilk consistency W-criterion. Statistical processing of empirical data was implemented using the STATISTICA 10.0 (StatSoft, USA) statistical analysis package. Statistical reliability in the difference of results of pedagogical testing and competitive activities of athletes was determined by the nonparametric Wilcoxon T-test. Differences between groups were considered to be statistically reliable at $p<0.05$. The Brave Pearson correlation coefficient was used to determine the correlative relationships between the results of the testing tasks and the efficiency of the competitive activities.

Table1. Comparative analysis of the level of physical fitness of 17-20 years old basketball players

Playing position	Sprint ¾ court (s)		p<0.05	Line agility drills (s)		p<0.05	Vertical jump (cm)		p<0.05
	Ukrainian players	NBA players		Ukrainian players	NBA players		Ukrainian players	NBA players	
Point guard	3.69±0.17	3.16±0.14	+	11.31±0.74	10.89±0.28	-	69.66±4.45	78.40±6.64	+
Shooting guard	3.78±0.23	3.21±0.08	+	11.61±0.38	10.92±0.47	+	64.83±3.97	78.48±7.98	+
Small forward	3.89±0.16	3.28±0.09	+	11.92±0.26	11.27±0.54	-	64.16±4.16	79.67±4.78	+
Power forward	4.06±0.20	3.29±0.09	+	11.83±0.38	11.34±0.42	-	62.83±3.86	75.01±9.04	+
Center	4.34±0.18	3.42±0.18	+	12.47±0.38	11.89±0.50	-	57.21±3.70	71.30±10.23	+

3. Results

Data published by American experts on the annual testing of new recruits during the "Draft" to the NBA (over a period of almost twenty years) made it possible to compare the level of physical fitness of American players and 29 young athletes aged 17-20 who participated in our research (Table 1).

Differences 17-20 years old Ukrainian basketball players had worse results when performing the test to determine speed capabilities (3/4 court sprint) compared to their American peers. This tendency was observed for basketball players of all playing roles.

The athletes we compared were approximately the same age (from 17 to 20 years old). It is known that the "Draft" procedure takes place in the USA in the summer, on the eve of the next game season. The completion of the student championship falls on the end of March and the beginning of April; it is during this period that the playoffs of the strongest student basketball league NCAA 1 (march madness) are held. That is, for almost two months, the athletes who are preparing for the draft procedure in the NBA do not have full game practice (if you do not take into account training camps and other sports events).

The vast majority of tests used, for example, in the USA (tests for speed, coordination, strength, jumping tests), may not have such a dependence on the player's game practice, unlike, for example, the level of general and special endurance. However, nevertheless, it should be expected that a higher level of "sports fitness", which players usually demonstrate during the competitive period (in season), should affect the quality of performance of these testing tasks.

According to the results of the test, Ukrainian basketball players were significantly inferior to players undergoing the "draft" procedure in the NBA. Ukrainian basketball players had worse results during the test for determining coordination abilities compared to candidates for the NBA. This difference was especially noticeable for "shooting guards". There were no significant differences in the results of the test for basketball players playing other positions.

So, for example, the average time of performing the coordination test (Line agility test) by young Ukrainian basketball players without taking into account the playing role was 11.80 ± 0.57 seconds, and the athletes who went through the "Draft" procedure to enter the NBA performed this test in an average of 11.26 ± 0.58 seconds.

It is necessary to take into account the playing role of athletes in the process of assessing the results of pedagogical tests. Taller and heavier players, who mainly play in attacking positions (power forward and center), perform worse in almost all testing tasks that are related to the speed of their execution and coordination of athletes' movements. Significant differences between Ukrainian and foreign players were observed in the results of vertical jump.

This is also confirmed by the results of the test to determine the level of endurance (Figure 1). Back-court players during the Yo-Yo test (RL1) were able to cover a much greater distance than centers and forwards. The Yo-Yo test is a modified version of the Beep-test developed by the Canadian scientist Leger et al. in 1988 [15]. In contrast to the classic endurance test, the Yo-Yo test assumes the presence of rest pauses between performing shuttle segments [16-18]. This mode of motor activities is more specific to the conditions of the structure of competitive activities in competitive team sports, where intensive game segments of the game alternate with short rest pauses. This version of the test is not usually performed in the United States. It is most often used in European basketball.

The Yo-Yo shuttle test was conducted by us several times during the preparatory and competitive periods. The results shown by the athletes during the competitive period were significantly higher (p<0.05) than the similar indicators that were demonstrated in the preparatory period.

These indicators should be used quite correctly in the selection process, taking into account the dynamic nature of the player's level of fitness and its dependence on the action of many factors in competitive sports. This approach will allow to avoid the strategic mistake of selecting not the most gifted athletes, but the most prepared ones at this stage.

One of the important tasks of the research was to determine the structural interrelationships between the effectiveness of pedagogical tests and the results of the competitive activities of basketball players who are at the stage of preparation for the sport of higher achievements. Establishing such connections allows, in our opinion, to determine the range of indicators and criteria that should primarily be paid attention to during the testing of young athletes in order to determine the level of their physical fitness and make a further decision regarding selection to the team.

The conducted correlation analysis made it possible to reveal significant relationships, both between the results of individual pedagogical tests, and to establish their connection with indicators of technical and tactical activities in matches. High correlation relationships were observed between the results of the coordination test and the ¾ court running (Figure 2).

The use of the strain-gage platform during the vertical jump test made it possible to determine the indicators of the maximum and relative take-off force. Thus, the players of shorter stature had the highest relative take-off force. These were predominantly basketball players who play in the positions of point guard and shooting guard. Basketball players playing in the guard line also had better results in the take-off test in cm. Centre players showed an average result at the level of 57.2 ± 3.7 cm, and back-court players $- 69.4 \pm 4.45$ cm.
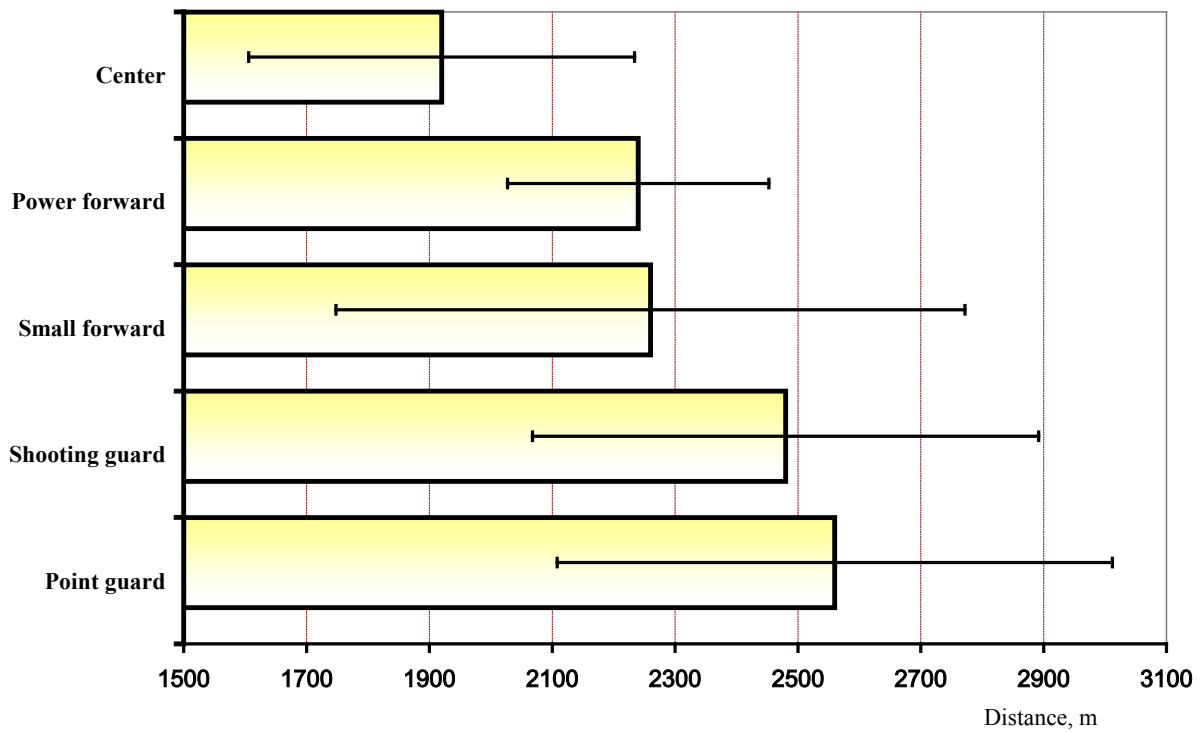
Figure 1.   The results of the performance of the Yo-Yo test (RL1) by Ukrainian basketball players aged 17-20, taking into account their playing roles
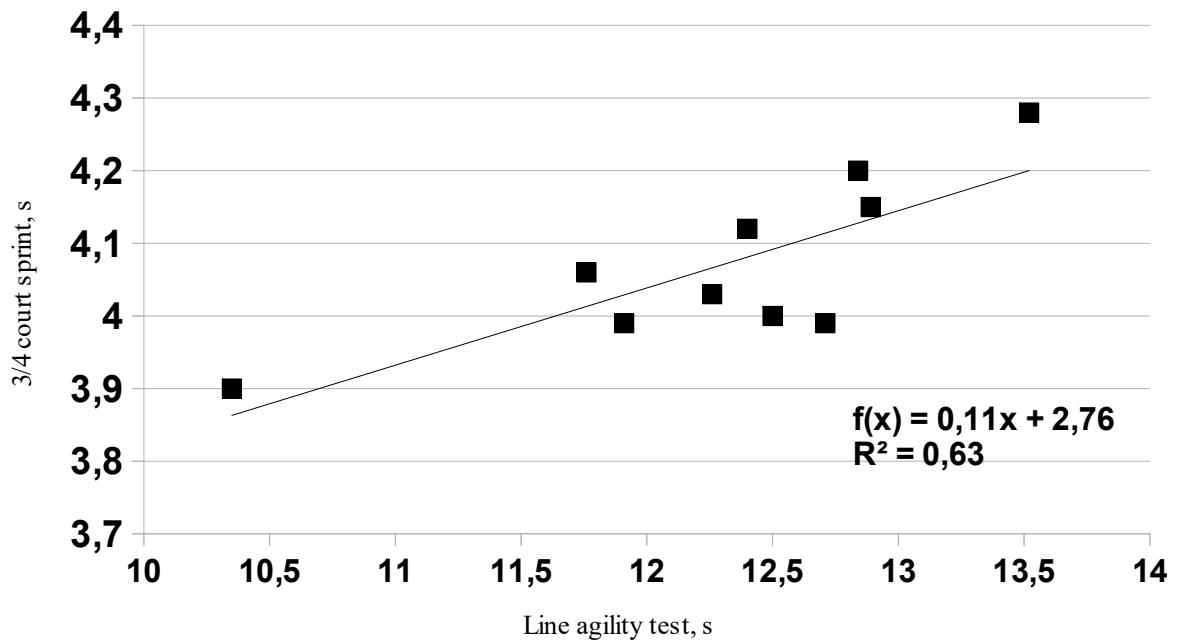

$$f(x) = 0{,}11x + 2{,}76$$
$$R^2 = 0{,}63$$

Figure 2.   Correlation of the results of the ¾ court running (court sprint) test and the test for determining coordination abilities (Line agility test)
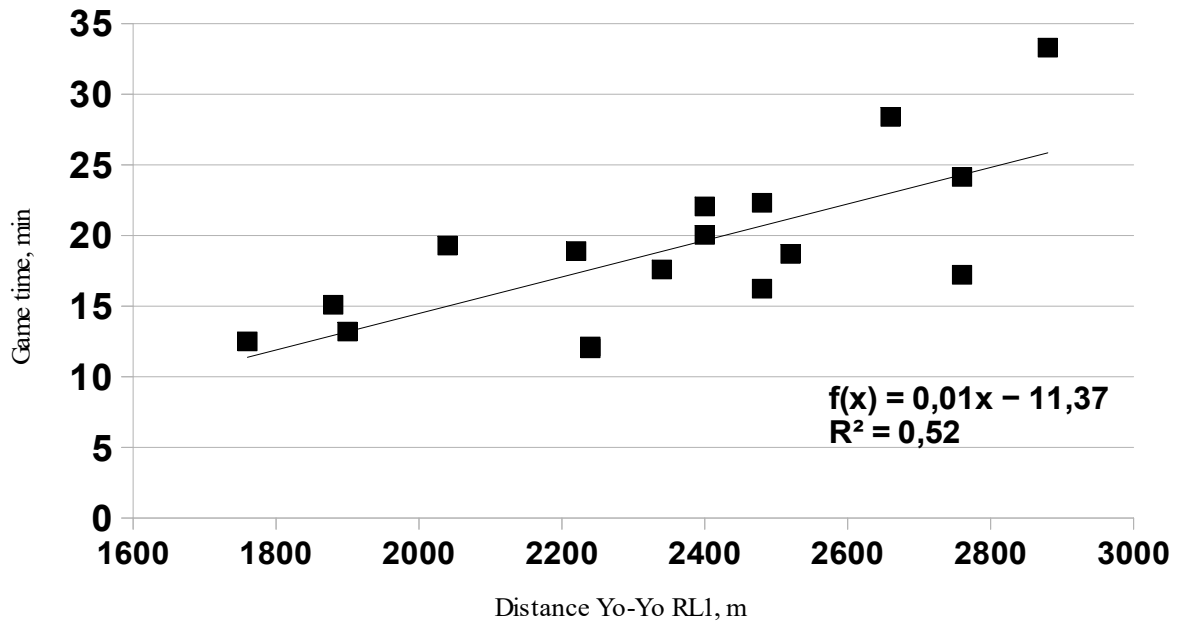
Figure 3. The relationship between the distance travelled in the Yo-Yo test (m) and the playing time spent on the court (min) in official matches by players of youth teams of Ukraine

Table 2. Morphofunctional characteristics of basketball players, taking into account their playing role (17-20 years, Mean±SD)

Playing position	VO$_2$ max, ml.kg^{-1}min^{-1}	Voluntary ventilation, l.min^{-1}	Vital lung capacity, l	Peak expiratory flow, l's^{-1}	Load intensity, Wt
Point guard	57.05±3.78	144.55±12.83	7.54±1.02	11.10±1.18	357.50±16.26
Shooting guard	55.60±3.02	141.70±16.87	7.89±1.16	11.95±1.36	325.14±36.51
Small forward	53.35±4.08	146.50±21.05	7.38±0.98	9.15±1.06	343.18±24.05
Power forward	52.95±3.65	166.25±14.12	8.72±0.80	11.68±1.92	342.70±37.90
Center	49.10±4.63	150.05±19.20	9.38±0.76	8.79±1.04	315.50±18.32

Similar differences between the roles can be seen if you analyze the results of the vertical jump by candidates to get to NBA clubs (Draft combine). Thus, the average result during the performance of the jump test for back-court players is at the level of 78.4 ± 6.6 cm, for centers – 71.3 ± 10.2 cm.

The obtained correlation relationships indicate the importance of using the Yo-Yo test to determine the level of a player's functional fitness. Basketball players who performed better on the shuttle endurance test usually spent more time on the court (Figure 3).

The level of manifestation of both general and special endurance apparently allowed more prepared players to maintain intense competitive activities for a longer time during the match. The correlation coefficient between the distance covered in the test (m) and the playing time on the court (min) was r = 0.722.

The obtained relationship confirms the informativeness of the test for determining the level of functional readiness of basketball players for competitive activities.

The study data on the functional capabilities of basketball players with different roles, who prepare for higher sports achievements, are presented in Table 2. The average level of VO$_2$ max in point guards was 57.05±3.78 ml.kg^{-1}min^{-1}. The lowest VO$_2$ max values were found in centers – 49.10±4.63 ml.kg^{-1}min^{-1}. In our study, the level of VO$_2$ max in players decreased linearly from the first to the fifth position. During the step test, the highest values of maximum voluntary ventilation were recorded in power forwards, the lowest – in defensive players (point guards and shooting guards). During laboratory testing, the indicators of maximum voluntary ventilation of power forwards reached the level of 166.25±14.12 l.min^{-1}. The highest values of intensity of the work performed during the test (W) were observed in point guards. The average level of maximum load during the step test was 357.50±16.26 Wt. During testing, the lowest intensity was achieved by centers – 315.50±18.32 Wt (Table 2). The results of the research of functional indicators of basketball players of different game roles are more widely presented in our previous article [14].

4. Discussion

The process of assessing playing opportunities in basketball needs to take into account many aspects of the specific structure of training degree. This is the level of tactical degree of training and tactical thinking, the ability to understand and instantly analyze the events taking place on the court, creativity in decision-making and much more. The sports result shown at the competition at a young age may not yet have such a decisive significance as at the final stages of many years of improvement [19].

An important factor in increasing the level of sportsmanship of basketball players at the stage of preparation for higher achievements is a high level of physical and functional degree of training. It is these abilities that create the necessary foundation for the effective withstanding of large physical loads of sports of higher achievements [14,20,21]. The tests recommended by specialists to determine the level of physical fitness of basketball players have confirmed their informativeness and can be recommended to solve the tasks of selecting basketball players in the process of youth national teams staffing for participation in official international matches or individual tournaments.

During the preparation for such competitions, the coaching staff have a short period of time, within which it is extremely difficult to make significant changes in the players' level of functional degree of training. Testing the functional degree of training of candidates for the national team, for example, using the Yo-Yo test, will allow you to quickly identify the most prepared athletes and make appropriate management decisions in the future.

In the process of assessing the basketball players' level of physical fitness, it is necessary to take into account the playing role of athletes and use appropriate scales to objectively determine their individual capabilities. During the performance of testing tasks related to the study of the level of speed, speed and strength as well as coordination abilities, the players of the defending line demonstrated significantly better indicators of their degree of training.

The analysis of the distance covered (m) by basketball players of different playing roles in the Yo-Yo Recovery Level 1 test allowed us to confirm the data of the specialists [17,18,22] regarding the superiority of back-court players over forwarders and centers. In our research, on average, the ball handlers ran in the test – 2560 ± 452 m, the shooting guards – 2480 ± 412 m, the small forwards – 2260 ± 512 m, the power forwards – 2220 ± 212 m, the centers – 1920 ± 214 m.

The conducted correlation analysis made it possible to confirm the informativeness of the pedagogical tests recommended by the specialists and to establish their connection with the effectiveness of the implementation of individual technical and tactical actions in the match. The results of the Yo-Yo shuttle endurance test had significant correlation relationships with the amount of playing time a basketball player spent on the court.

In turn, the obtained data also confirm the opinion of many experts about the need to gradually bring young basketball players to the level of sports of higher achievements [23-26]. Young athletes are not yet ready for significant loads and speeds of "adult basketball". After completing training in the system of children's and youth basketball (on average 16-17 years old), each year of training and regular participation in high-level competitions plays an extremely important role in the growth of sports results and the future professional career of the player.

5. Conclusions

The role of physical and functional degree of training has significantly increased both in professional basketball and in the system of youth sports in today's conditions of intensification of competitive activities in basketball, increasing requirements for the level of athletic training of players. Determination of strengths and weaknesses in the individual structure of a basketball player's physical fitness, permanent monitoring of the dynamics of their changes in young athletes in the process of targeted training, can be one of the reliable criteria for predicting the player's prospects during selection into the system of sports of higher achievements.

Young Ukrainian basketball players' level of physical fitness was significantly ($p < 0.05$) lower than the results demonstrated by foreign players during testing at the NBA draft. This trend was observed for all game roles without exception.

Statistically significant correlation relationships were revealed between the level of physical fitness in basketball players aged 17-20 and the effectiveness of their competitive activities in the match, which allows them to be recommended as an informative indicator of the readiness of individual players and the team as a whole for competitions.

The determined functional characteristics (VO_2max, MVV, VLC, PEF, W) serve as informative criteria in the process of stage-by-stage and ongoing monitoring of the individual condition of players. They are dynamic and can be used in different age groups, taking into account the specifics of training in a team and individually.

Disclosure Statement

No author has any financial interest or received any financial benefit from this research.

Conflict of Interest

The authors state no conflict of interest.

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