

# Anthropometric indicators of young basketball players aged 11-14 and 14-17 as a selection criteria of young players for basketball teams (based on the results of the “Sibur – Zenit” Basketball School program)

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**Abstract.** The Basketball School program was launched to track and support young talented basketball players in Russia under the aegis of the Russian Basketball Federation and the SIBUR gas processing company. Physical and technical conditions of players and their anthropometric indicators are monitored each year. The program covers a three-year period and is held annually in several stages. The stages include testing the physical and motor conditions of young players, field sessions with the coaches of the Russian professional basketball team, training camps for talented players and seminars for coaches of youth basketball teams. A study was conducted based on the results obtained during the testing. It was aimed to determine the periods of increase in physical qualities and motor abilities among young basketball players. The relationship between height and other anthropometric indicators was indicated, they can serve as a selection criteria for basketball teams. The results obtained can be used in the formation of training methodology for young basketball players.

## 1 Introduction

Modern basketball is characterized by athleticism, technical diversity, high level of physical contact, and dynamism. Some experts define basketball as a high-intensity sport in which anaerobic metabolism plays a key role [1, 2]. The strict requirements imposed on the game lead to the fact that basketball players face close competition at an early age. Anthropometric assessment of physical and somatotype analysis (height and body weight, shoulder width, bent arm girth, and arm length) can be the key for selection and identification of promising players [3]. The development of motor skills and the improvement of morphological indicators play an important role in the player formation

process [4-6]. The purpose of this study is to monitor, identify, and substantiate the relationships between various anthropometric indicators, which serve as a selection criterion of young players for basketball teams. The Basketball School program was studied to achieve this purpose. The program is implemented under the aegis of SIBUR gas processing company.

In recent years, SIBUR has been implementing the Basketball School program to support the development of sport in Russia. During this time, much has been done to develop youth and student basketball, as well as to support professional sport. The company is the official sponsor of the Zenit St. Petersburg men basketball team that competes in the VTB League. The company runs programs that are aimed at identifying and supporting talented young players, organizing master classes for players and seminars for coaches, assisting construction and reconstruction of gyms across Russia every year.

## **2 Materials and Methods**

The important tasks of the program are to monitor the anthropometric data, as well as physical and technical condition of players. It should be noted that the program is run for an older group of players (14 - 17 years old) with a number of tests, whilst the younger group of players (11 - 17 years old) was subject to different control requirements. Participants filled out questionnaires indicating the height of their parents before testing.

At the first stage, 156 basketball players aged 14-17 (n=156) were monitored [7]. The second stage of the study included 85 players: 24 people aged 11, 24 people aged 12, 25 people aged 13, 12 people aged 14, the later represented the team of the strongest players of Voronezh region. The Voronezh team (14-year-old players) is multiple winner of the Russian Championship. The team took part in two stages of testing. The following anthropometric indicators were measured: height + arm length extended upward (measured with a mark on a wall), arm length, hand length, hip length, foot length.

To identify the actual strength abilities, we used a press test with the right and left hand, performed on a dynamometer (kg). To identify speed-power abilities we used the height of the standing vertical jump according to Abalakov (cm), the height of the jump in motion with reaching the mark on the basketball backboard (wall) (cm), triple jump distance (cm), throw distance of a medicine ball (cm). "Running in place for ten seconds" test was used to identify speed abilities by counting number of movements. The level of special endurance of movements was determined according to the "Shuttle run for 40 seconds" test (m). The run was performed from the base line to the base line with a turn, and backward running. Another group of tests was introduced to determine the level of movement coordination, special game skills and basketball skills of players. Among those tests is a "5 rays" test, which consists in radial movements from a baseline in the defensive stance with step slide to a 3-point line back and forth, measured by the travel time of all radial movements (s). Another test was "5 poles" which consisted in zig zag motion around 5 poles back and forth while dribbling the ball, the test was measured in seconds. The test "Shooting from 10 spots against time" was used to determine the shooting accuracy, the result was measured by number of successful hits on the basket. The reaction time was recorded with visual reaction time meter; the best time (ms) was selected out of three attempts.

## **3 Results and Discussion**

Height is an important indicator of human development, with hereditary factors having a significant influence on human growth. Further, we present the growth dynamics of basketball players in the Voronezh region, in the summary table describing the height

indicators of young athletes 11-14 years old. We also compared the height parameters of the basketball players' parents in a large group (Table 1).

**Table 1.** Height indicators of young athletes and their parents (11-14 and 14-17years old) (M ± m)

Age	Number of people	Child's height, cm	Father's height, cm	Mother's height, cm
11-14 years old, (M ± m)				
14*	12	177.67 ± 8.40	184.42 ± 8.93	174.67 ± 7.30
13	25	174.96 ± 9.06	184.64 ± 9.63	170.32 ± 8.48
12	24	165.32 ± 10.56	185.44 ± 10.12	165.0 ± 9.66
11	24	160.72 ± 10.42	181.53 ± 11.85	165.82 ± 6.06
14-17 years old, (M ± m)				
17	50	183.71 ± 6.65	185.43 ± 7.44	169.02 ± 6.23
16	35	183.55 ± 6.92	184.46 ± 5.51	170.03 ± 5.11
15	31	180.61 ± 7.73	183.19 ± 6.98	168.12 ± 5.74
14	40	172.37 ± 8.94	183.11 ± 7.56	169.09 ± 6.18

Note: \* - the national team of the Voronezh region, multiple winner of the Russian Championship

Considering the height of the players, it can be noted that in the age group from 11 to 14 years, there is an increase in height by 5-7 cm annually. Comparing the height indicators of children and parents, the height of father was recorded from 185.44 ± 10.12 cm to 181.53 ± 11.85 cm, which is higher than the average indicators of an adult. Mother's height varied from 174.67 ± 7.30 to 165.0 ± 9.66.

Table 1 shows the height data of the Voronezh Regional team. The team is a multiple prize-winner of the Russian Championship. At the age of 14, the average height of the team is 177.67 ± 8.40 cm, the difference with peers who play basketball is 5.29 cm, has significant differences (P < 0.05). At the same time, father height averages 184.42 ± 8.93 cm, there is no significant difference with other age groups. Mother height, in comparison with other groups, is higher on average by 5 cm, which has significant differences (P < 0.05). Therefore, it can be assumed that mother height is more important for the initial selection of children in the basketball section. The correlation between the height of son and father is r = 0.308, and the correlation between the height of son and mother is r = 0.668.

In the age category of 14-17 years, father height, on average, by age groups varies from 185.43 ± 7.44 cm to 183.11 ± 7.56 cm, mother height varies from 170.03 ± 5.11 cm to 165.00 ± 8.70 cm. At 14, children catch up with their mother in height, at 16-17 they catch up with their father. Besides height, we studied athletes' body weight indicators, height + arm length extended upward (measured with a mark on the wall), arm length, hand length, hip length, foot length (Table 2).

**Table 2.** Anthropometric indicators of the studied groups (11-14 years old) (M ± m)

Age, years	Height, cm	Weight, kg	Height + Arm, cm	Arm length, cm	Hand length, cm	Hip length, cm	Foot length, cm
14	177.67±8.40	63.32±15.56	227.50±11.36	177.00±10.26	19.33±1.23	39.25±3.19	28.00±2.20
13	174.96±9.06	62.70±14.61	255.56±12.21	176.00±10.63	19.22±1.09	39.11±3.01	27.76±1.65
12	165.32±10.56	50.40±12.34	213.14±14.14	165.78±12.50	18.00±1.49	37.57±2.53	26.14±2.18
11	160.72±10.42	49.47±8.56	206.58±13.98	162.07±11.18	17.62±1.55	35.25±11.59	25.45±2.21

**Table 3.** Anthropometric indicators of the studied groups (14-17 years old) (M ± m)

Age, years	Height, cm	Weight, kg	Height + Arm, cm	Arm length, cm	Hand length, cm	Hip length, cm	Foot length, cm
17	182.61±6.54	74.35±12.93	87.62±12.26	79.48±9.03	19.48±1.73	98.54±10.48	44.03±1.89
16	182.64±6.93	73.19±10.80	86.25±6.25	78.72±9.13	19.33±1.68	97.12±14.80	43.93±2.11
15	181.63±7.73	71.65±9.46	83.97±13.95	77.92±7.24	19.69±1.49	95.23±14.03	44.04±1.90
14	172.48±8.85	59.37±14.01	80.05±12.33	72.92±11.77	18.64±1.86	97.97±11.59	42.10±1.96

The length of arm and hand is important for basketball, it is necessary to handle and catch the ball, intercept, shoot, dribble it. In the age category of 11-14 years, the greatest increase in height (5.8%) was noted at the age of 13. Basketball players of this age are 24.4% heavier. The largest increase at the age of 13 was recorded by 5.8% for height + arm; by 6.2% for arm length, by 6.7% for hand length. The highest increase is also noted for hip length at the age of 12 (by 6.6%) and 13 (by 4%). The greatest increase in the foot size is observed at the age of 13 (by 6.2%). There is a close correlation between the indicators of height and body weight ( $r = 0.812$ ), height and height + arm ( $r = 0.915$ ), height and arm length ( $r = 0.824$ ), height and hand length ( $r = 0.710$ ), height and hip length ( $r = 0.860$ ), height and foot length ( $r = 0.912$ ).

In the age category of 14-17 years, besides height and weight, chest circumference, arm and hand length, leg length and shoe size were measured. In the group from 14 to 15 years, the greatest increase in height was recorded by an average of 8.24 cm ( $P < 0.05$ ) (Table 3). In the group from 15 to 16 years, there was an increase in height by 3 cm on average, but not significantly ( $P > 0.05$ ). At 16, the height was equal to 182.64±6.93 cm. At 17, the height was 182.61±6.54 cm on average, and had no significant differences with the age groups of 15 and 16 years. In the groups of 16 and 17 years, from 15 to 20 % of the players are taller than 190 cm.

The correlation coefficients between height and body weight are equal ( $r = 0.824$ ), height and chest circumference ( $r = 0.586$ ), height and arm length ( $r = 0.925$ ), height and hand length ( $r = 0.720$ ), height and foot length ( $r = 0.801$ ), height and shoe size ( $r = 0.920$ ).

The dynamics of physical and technical condition is important when training young athletes [8-10]. The data on the level and growth of physical abilities is shown in Table 4.

During the studied age period, there was an increase in strength in the hand press exercise, both with the right and left hand, by an average of 11 kg. At the same time, the press with the right-hand result in each age group is 2 kg higher. The maximum indicators were recorded for 13 year-old players, the increase in the strength of the right hand increased by 8.13 kg (31.4%). A significant increase in the left-hand strength indicators was noted by 5.79 kg (24.3%) among young basketball players at the age of 13 (Table 4).

In jumping tests, a significant increase in indicators was noted in jumping in motion with a mark on the backboard for the 12-year-old players (by 6.5%). This indicator grows by 8-16 cm on average for each age. Increase by 2.94 cm (7.4%) was noted for the 13 years old group and by 5.6 cm (13%) for the 14 years old.

Medicine ball throw test determines the speed-strength abilities of core and arms. For this test, increase rates were recorded in the group from 13 to 14 years old, which amounted to 19% [11, 12].

In studies of the older age group of 14-17 years, the greatest increase in speed-strength indicators was noted at the age of 14-15: by 4.2% for the 20 m running, by 6.7% for the 20 m running with dribbling ball, by 13.2% for the vertical stand jump, by 8.4% for the two steps jump. For comparison, at the age of 16 and 17, the indicators of the increase in jumping ability decrease to 1.5-2% [13]. The speed of footwork on the contrary increased in the age range of 16 and 17. The speed was measured by steps in a defensive stance over baseline (back and forth) and lateral steps along the baseline. For steps over the baseline,

the increase was on average by 2.7% in the 16-year-old group, and by 28.3% in the 17-year-old group. For steps along the baseline the increase is by 8.1% (Table 5).

The indices of special physical and technical condition required for the playing activity of young players are presented in Table 6. The special speed endurance in the "Shuttle run for 40 seconds" test grows approximately equally in all age groups (by 5.5% on average). In the exercise of movement in the defensive stance "Five rays", there is an increase in indicators from 11 to 12 years old. At the age of 13, they decrease, apparently, due to the body growth in length by 5.8%, and a significant increase in body weight. At the age of 14, the speed of movement increases again [14]. The same dynamics can be seen in the "Five poles" test, where between 11 and 12 years old the speed increases by 5.8%, whereas between 12 and 13 years old it decreases, then it grows to 7.5%. The coordination of movements in the accuracy of shooting undergoes the same changes, when the percentage of hits from age-to-age changes as 40.4%, 14.3%, 63.3%, respectively, by age.

**Table 4.** Results of testing the general physical condition of young basketball players (11-14 years old) ( $M \pm m$ )

Age, years	Right hand press, kg	Left hand press, kg	Jump height mark on the wall, cm	Height of the jump from the spot, cm	Triple jump, cm	Throw of the stuffed ball, cm
14	33.05±9.98	31.43±9.45	276.00±14.38	48.25±8.93	606.9±37.01	1084±104.2
13	33.98±9.45	29.57±8.60	269.36±15.42	42.64±8.58	593.8±49.52	909.4±151.3
12	25.85±7.37	23.78±5.82	257.07±15.28	39.7±6.17	567.4±51.49	845.2±219.9
11	22.70±6.13	20.27±6.13	241.42±14.22	39.2±6.56	531.4±50.92	662.2±150.2

**Table 5.** Results of testing the general physical condition of young basketball players (14-17 years old) ( $M \pm m$ )

Age, years	Running 20 m, s	Running 20 m with dribbling, s	Height of the jump from two steps, cm	Height of the standing jump cm	Footwork (over the baseline) amount for 30 s	Footwork (along the baseline of 4 meters), amount for 30 sec
17	3.38±0.27	3.57±0.27	309.50±13.20	52.92±3.73	119.56±11.09	22.14±2.28
16	3.38±0.30	3.65±0.22	303.89±13.60	52.64±4.03	93.19±14.80	20.49±2.11
15	3.40±0.23	3.62±0.26	304.90±15.71	48.09±6.65	90.78±15.52	19.97±2.18
14	3.55±0.35	3.88±0.37	281.22±14.20	42.50±6.57	89.97±15.92	19.68±1.77

Considering the indicators of reaction speed [15, 16], no special changes were found; over the four-year period, the reaction speed decreased by 3-4 ms, on average for the group.

In the older age group of 14-17, the following tests of technical condition were used (Table 7): free throws, the number of scored out of 10 shots, layup from 2 steps out of 10 attempts, standing jump shots out of 10 attempts. Dribbling tests included standing crossover for 20 seconds, passing the ball test included passing the ball into the wall from the 3 m distance for 30 seconds.

The greatest increase in performance in shooting tests was recorded at the age of 16, so the accuracy of the free throw increased by 19%, the middle range jump shots increased by 28.4%.

In the dribbling and passing test, the highest rates were noted at the age of 17, by 18.8% and 26.9%, respectively. This can be associated with a significant increase in muscle strength of the shoulder girdle, back muscles and abdominal muscles.

A special role in the preparation of young athletes is played by the dynamics of physical and technical training. It should be noted that standing jump and jumping in motion is the basis for many technical game actions for basketball players [16]: rebounding, intercepting the ball, passing, shooting, performing defensive actions – blocking shots, stealing the ball etc.

Therefore, when analyzing the playing activity at the Russian Championship of 14-year-old players, a correlation was established between the height of a standing jump and points scored ( $r = 0.620$ ), standing jump and number of 2-point shots ( $r = 0.574$ ), standing jump and interceptions ( $r = 0.594$ ). It agrees with earlier studies [16] that there is a high degree of correlation between the height of a jump in motion and the number of individual game elements successfully performed in the game, such as: total rebounds ( $r = 0.820$ ), rebounds on one's backboard ( $r = 0.726$ ), offensive rebounds ( $r = 0.842$ ).

**Table 6.** The results of testing the special physical and technical readiness of young basketball players (11-14 years old) ( $M \pm m$ )

Age, years	5 rays, s	Shuttle for 40 s, m	5 poles, s	Running in place for 10 seconds, qty	Jumpshots from 10 spots, points	Reaction speed, ms
14	23.29±1.33	201.41±5.94	21.28±1.24	45.58±9.62	11.66±2.49	643.68±69.84
13	25.37±2.55	190.76±13.99	23.77±3.04	42.84±6.36	7.14±3.32	649.85±67.35
12	25.79±2.13	180.78±16.05	23.01±1.81	41.62±8.38	6.84±3.42	652.41±100.8
11	28.59±2.98	171.12±23.9	25.29±1.66	40.78±6.12	4.87±3.93	658.0±66.70

**Table 7.** The results of testing the technical readiness of young basketball players (14-17 years old) ( $M \pm m$ )

Age, years	Free throws out of 10, the number of shots scored	Layup from two steps out of 10, the number of shots scored	Jump shot out of 10	Standing crossover in 20 sec, qty	Passing the ball for 30 sec to a distance of 3 meters, qty
17	7.06±1.39	9.22±0.94	6.88±1.24	59.28±6.62	44.16±3.49
16	6.32±1.59	8.76±1.99	6.27±1.84	52.84±9.36	37.14±7.32
15	5.22±1.13	9.28±1.05	4.01±1.51	51.42±7.38	34.84±7.42
14	5.23±2.12	9.12±1.18	4.89±1.66	53.75±9.12	34.87±8.93

According to the reaction speed indicators [17, 18], no special changes were found; over the four-year-age period, reaction speed decreased by 3-4 ms on average for the group.

## 5 Conclusion

Thus, the height indicators of young basketball players are interrelated with the height of parents, while mother height is more significant ( $r = 0.668$ ) for the initial selection of a young basketball player. The relationship between height and other anthropometric indicators was indicated, they can serve as a selection criteria for basketball teams.

The level of physical and technical condition indicators of young athletes are inextricably linked to the change in their anthropometric data [19, 20]. An increase in height and body weight affects strength and speed-strength abilities, which significantly increases at the age of 13-15. At the same time, the coordination abilities increase up to 12 years [21], further a decline takes place, and by the age of 14, they reach the average level. Intermuscular coordination of movements significantly increases by the age of 16-17, with an increase in the individual muscle group strength, which affects the speed and accuracy of movements of shooting, passing and dribbling.

The data obtained can be used to develop approaches and methods for sports training of young basketball players. The data can serve as certain guidelines for the selection of players for basketball teams [22], as well as guidelines for the transfer of players to the next age group.

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