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AGE-RELATED DIFFERENCES IN THE DEVELOPMENT OF MOTOR ABILITIES IN VOLLEYBALL

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ABSTRACT

There are a large number of publications related to conditioning in volleyball and in general. However, a very small part of them are related to the development of motor abilities in an age aspect. Such a study would be very difficult to implement, but at the same time, it would be beneficial in terms of the selection and sports orientation of youth volleyball. Volleyball as a sport has developed extremely dynamically in recent years, which makes it even more demanding in terms of fitness. The basic skills necessary for successful implementation in sports are complex and based on the athletes' ability to jump, sprint, and hit. From this point of view, the interest in this research was dictated, with the primary goal of determining the values of the main signs related to the volleyball game and compiling normative tables for control and assessment of preparedness. The research tasks also arise from the goal set in this way. To investigate the differences in the main essential characteristics of the volleyball game regarding age. To propose standards of control and evaluation. The methods we used to solve the problems are anthropometry, chronometry, tensiometry, speedometry, and mathematical-statistical methods (frequency, variation analysis, and sigma method). Results: The most significant increase in women was observed in the results of the jump tests and the speed of the serve (over 20 %) and smaller within 10% in the running tests. We attribute these results to the fact that the listed movements emphasize the training and competition process. Based on the obtained results, norms for evaluating the readiness of the contestants have been drawn up.

Keywords*: volleyball, tests, jumps, speed, anthropometrics.*

INTRODUCTION

Volleyball is one of the most popular sports and, as such, is subject to many analyses. They are directed in several topics: analysis of motor activity, analysis of factors of sports achievement or models for predicting the outcome of a given match or tests for assessment and control in individual age groups, and qualification or strength and conditioning models (Black, 1995; Powers, 1996; Nesser & Demchak, 2007; Taware et al., 2013; Silva et al., 2016; Drikos et al., 2019; Bunn et al., 2020; Weldon et al., 2021; Marzano-Felisatti et al., 2022). Despite the vast range of topics and lines of reasoning, many ambiguities are still related to volleyball. To a large extent, all this is due to the constantly changing rules of the game and the need for better understanding. The most significant number of studies are related to elite men's volleyball and, to a lesser extent, to women's or children's and youth's volleyball. Such volleyball knowledge would bring more accurate empirical data on athletes' physiological and conditioning requirements. This information can be obtained through time motion analysis, but it is less widely used than in other team sports. The first reports of such analyses in volleyball date back to 1992, although the sport has over 100 years of history. To date, many articles are related to technical-tactical actions, and a small number of them treat this problem.

Nevertheless, these data provide essential information to strength and conditioning specialists regarding the motor needs and the abilities behind them for successful implementation in volleyball. This, in turn, would lead to optimizing the training process. Research in this direction has been done by some authors, from which we can derive some basic game characteristics.

Volleyball is an intermittent sport requiring a certain fitness level and aerobic and anaerobic power to perform complex coordination movements (Gabbett & Georgieff, 2007). In this sense, aerobic power is necessary due to the long duration of bouts and training loads, but more critical is anaerobic power, which is required for basic movements that are performed at and near maximal speed and power of effort. The very movements of the volleyball player are determined by the two phases of the game: active and passive or attack and defense. Nevertheless, according to different authors, between 65 and 136 different types of rebounds are performed in a volleyball match, regardless of the age and gender of the players (Borràs et al., 2011). The duration of the bouts varies according to the age and gender of the participants. However, it is within 6 to 14 seconds with a rest between individual high-intensity actions of 14-26 seconds or, in other words, in a ratio of 1:2 to 1:4 (Serrano et al., 2016). At the same time, the authors also notice some differences in this regard, which in turn requires an individual conditioning program to satisfy the needs of the volleyball player regardless of all the factors that influence the game. This will increase the efficiency of training and competition work and reduce the risk of injury.

On the other hand, the final result of the sports training process is building a successful adult athlete at the national and international levels. Information about these processes is even more scarce due to uncertainties about the profile of motor activity in volleyball at different ages and the development of motor qualities and abilities (Chunmei, 2021). Such an approach would provide a basis for constructing a scientifically based sports training system with precisely and clearly defined parameters for developing the main conditioning components in volleyball, namely the anaerobic potential.

To our knowledge, this is the first paper that studies anaerobic potential through different age groups after they were changed. Until now, no study has explored the development of motor abilities in volleyball of junior to senior women. The only studies that were conducted were conducted with a maximum of two age groups. Another novelty of this study is that it is the first to use such a great span of tests that could examine the development of anaerobic power in volleyball.

From everything said so far, the study‘s primary goal is derived, which boils down to determining the age dynamics in developing indicators characterizing the anaerobic potential in women‘s volleyball.

METHODS

The research was done among 228 female volleyball players from 6 volleyball clubs in Bulgaria, with an average age of 15.6 (12-39). The age distribution is shown in Table 1.

Table 1. *Frequency and distribution of the examined persons*

Age ⇩	Investigated persons (count number) ⇩	Height (cm) ⇩	Weight (kg) ⇩
12 years	7	173.6	61.7
13 years	37	169.4	56.4
14 years	48	172.2	60.9
15 years	39	174.3	63.9
16 years	31	176.8	65.4
17 years	27	177.9	71.9
18 years	15	175.5	68.6
19 years	12	175.0	74.5
20+ years	12	180.3	73.5

To realize the purpose of the overall research and the main tasks resulting from it, we used the following sports-pedagogical and specialized methods: Anthropometry (height and weight), Chronometry (speed and repeated sprint test), Speedometry (serve speed), Tensometry (explosive power test), and Statistical methods (frequency distribution, descriptive statistics, and sigma rule).

The 3-sigma theorem (rule) is also called the 68-95-99.7 rule. It is a statistical rule which states that for normally distributed data, almost all observed data will fall within three standard deviations of the mean or average of the data. In particular, the empirical rule predicts that in normal distributions, 68% of observations fall within the first standard deviation ($\mu \pm \sigma$), 95% within the first two standard deviations ($\mu \pm 2\sigma$), and 99.7% within the first three standard deviations ($\mu \pm 3\sigma$) of the mean.

Table 2 presents all the investigated indicators, the tests that characterize them, and the measurement accuracy.

Table 2. *Measured indicators and tests that characterize them*

№	Test	Investigated parameter	Precision	Measure unit
1	Height	Physical development	0.01	cm
2	Weight	Physical development	0.10	kg
3	20м running	Speed qualities	0.01	sec
4	SJ	Strength - speed qualities	0.10	cm
5	CMJ	Strength - speed qualities	0.10	cm
6	CMJA	Strength - speed qualities	0.10	cm
7	4x20 shuttle run	Speed endurance	0.01	sec
8	Serve speed	Strength - speed qualities	1.00	km/h

Testing procedures

Before the tests, the athletes did a standard warm-up within 15 minutes, including light running, general development exercises, specific running exercises, accelerations and starts, and stretching.

A trained specialist measured the height as a part of anthropometric tests. Height was measured while the athlete stood with legs together, arms by the body, legs straight, shoulders relaxed, and head in a horizontal plane, with heels, buttocks, shoulder blades, and back of head resting against a vertical wall. These measurements were taken in centimeters using a SOEHNLE 5003 digital height meter (Soehnle Professional, Gmbh Co., Backnang, Germany), which measures height within the range of 50 cm to 240 cm with an accuracy of 0.01 centimeter.

Weight was recorded using the Inbody 230. Competitors were measured barefoot by the race kit to the nearest 0.1 kg.

The speed measurement was performed with a Witty timing system (Microgate, Bolzano, Italy) with an accuracy of 0.01 seconds. The system consists of wireless photocells and reflectors for them. The cells are located at a height of 1 m and a distance of 2 m between the reflectors. The distance is measured in advance using a hand tape measure and marked with a colored sticker. Competitors start on a pre-prepared colored line 30 cm from the first cell, starting at will and running the distance with maximum effort. Scores are counted to 0.01 of a second by making two runs and taking the better score.

The repeated sprint abilities test (4x20m shuttle running) used the same route as the 20m running test and the same timing system disposition (Microgate, Bolzano, Italy). The only difference was that the volleyball players ran four lengths of 20 meters each without stopping and made three 180° turns at given markers. The results were counted in 0.01 seconds by making one run.

The competitors‘ lower limb‘s explosive power was measured by performing individual jumps on a force plate. The platform and software used to record, process, and analyze jump parameters is NORAXON USA, with a MyoForce module. The jumps were performed according to the following protocols:

- Squat Jump (SJ): From the starting position, a squat is performed at an angle between the hip and lower leg of 90°, with feet planted on the ground at shoulder distance. The hands are placed on the waist. From this static position, a quick extension of the lower limbs and an upward bounce are performed to reach maximum height. The lower limbs are in an extended position until the moment of landing.
- Counter Movement Jump (CMJ): This is performed from a standing starting position. Feet are shoulder-width apart, with feet planted on the ground and hands placed on hips. From this position, a quick squat (flexion) to 90° is performed, followed by an extension of the lower limbs and an upward bounce, in which the hands remain grasped at the player‘s hips. The lower limbs are in an extended position until the moment of landing.
- Counter Movement Jump with Arms Trust (CMJA): This is performed from a standing starting position. Feet are shoulder-width apart, with feet planted on the ground and arms raised overhead. From this position, a quick squat (flexion) to 90° is performed, in which the arms perform a quick downward and backward swing, followed by an extension of the lower limbs and an upward bounce, in which the arms perform a forward and upward swing and help lift the center of gravity (CG) to reach maximum height. The lower limbs are in an extended position until the moment of landing.
- To measure the flight speed of the ball when serving, a Radar Handheld Electronic Gun model 10-1900 is used, which measures results in the range of 16-322km/h (Bushnell et al., USA). Competitors perform a standard serve behind the end line in any direction to achieve maximum ball speed. The measurer stands 18 meters frontally opposite the service bounce. The ball is a standard all-age competition ball (Mikasa MVA, Mikasa Corporation, Hiroshima, Chūgoku). According to the manufacturer, the accuracy is up to 0.4 m/s (Bushnell, 2012).

The tests were performed in the following sequence, shown in Table 3.

Table 3. *The sequence of tests and rest intervals between them*

Sequence	Test	Trials	Rest
1	20м running	2	2
2	CMJ	1	2
3	SJ	1	2
4	CMJA	1	2
5	4x20 shuttle run	1	3
6	Serving speed	2	1

RESULTS

After the tests and the determined statistical procedures for summarizing the results, the following development trends were obtained for the individual indicators characterizing the anaerobic potential, as shown in Figures 1, 2, 3, 4, and Table 4.

Table 4. *Change in signs characterizing anaerobic potential by selected signs in the age aspect*

Age ⇩	20 m running % change	4x20 running % change	Serve speed % change	CMJ % change	SJ % change	CMJA % change
12 years	Base level	Base level	Base level	Base level	Base level	Base level
13 years	-3.9	-3.8	-6.8	3.8	3.2	7.64
14 years	0.8	0.2	7.8	-0.3	-1.6	-2.22
15 years	-1.4	-2.0	7.5	9.5	9.8	8.36
16 years	-0.8	0.2	4.1	1.5	4.0	2.96
17 years	0.9	0.5	2.6	0.0	-1.1	-0.39
18 years	2.2	0.4	0.8	-2.0	-3.5	-5.66
19 years	-7.6	-3.0	4.2	14.5	18.0	15.37
20+ years	0.1	-2.4	1.6	-2.1	-0.9	-2.95
Cumulative change	-9.7	-9.9	21.8	25.0	27.9	23.1

Based on the data from the table, an improvement in the result in the 20 m run was observed by 9.7% or 0.38 sec in the studied period from 12 years to women. Looking at the data in more detail, an apparent increase was observed between 12-13 years of age, after which a plateau in the development of speed abilities was noticed in the next five years (13-18 years), with the results varying within 3.67-3.78 sec, which difference is negligible. After this period, a jump in these abilities was noticed at the threshold of entering the age group of women, which also remained at the same level in women.

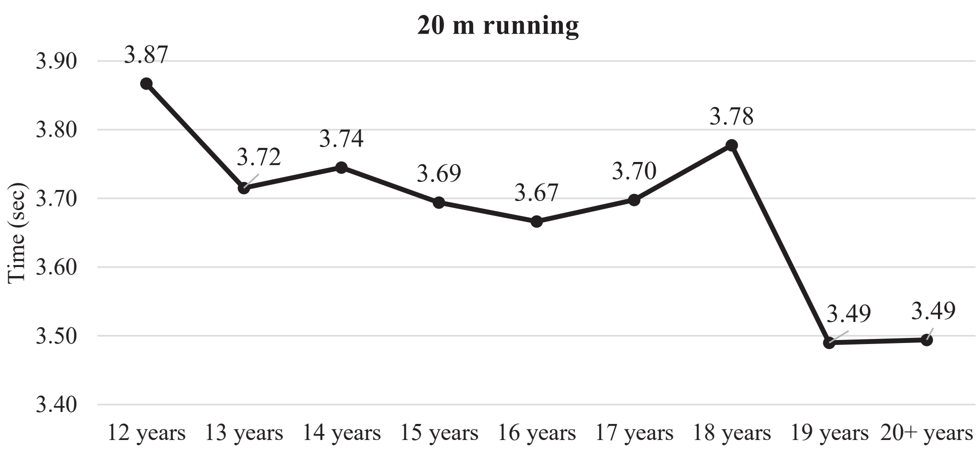

Figure 1. *Age dynamics in the development of speed abilities*

Speed endurance in women, as expressed by the 4x20 m shuttle run, showed a similar trend to speed ability; after the initial more significant improvement, there followed a plateau between 13 and 18 years, with a subsequent increase for the last two ages. The total increase was within 10%, with the most significant increase between 12 and 13 years of age. These increments were similar because a certain speed reserve is required to realize speed endurance, resulting from the high-speed abilities.

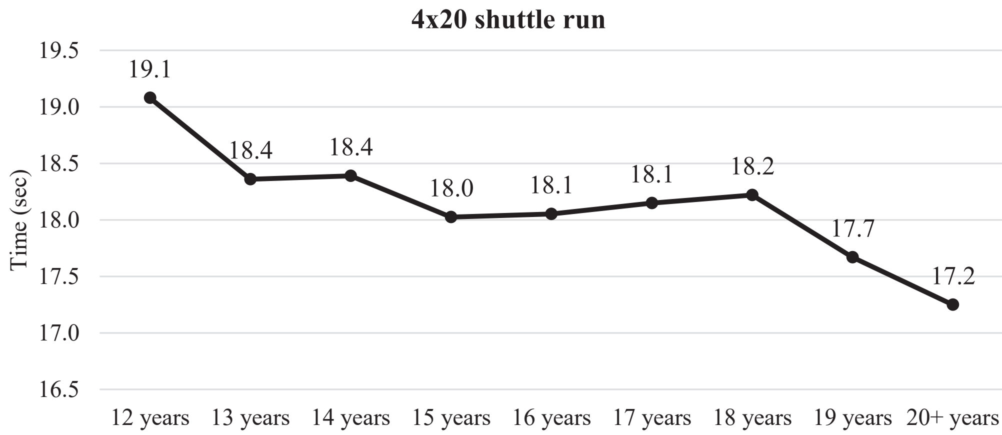

Figure 2. *Age dynamics in the development of repeated sprinting ability*

As for the execution of the serve, there was a trend toward a constant increase in the speed of the opening shot in volleyball. Here, we must consider that although the serve is an offensive tool, it is also a tactical one. The only drop in the speed of its execution was among the 13-year-olds. We attribute this decline to the transition from mini volleyball to children‘s volleyball, which was characterized by certain specifics in the rules and requirements for the players. Next to the women, there was an increase in the ball speed to 69.1 km/h. The total increase for the entire period was 21.8%. The most significant percentage increase was observed among 14-year-olds; after this moment, it gradually decreased.

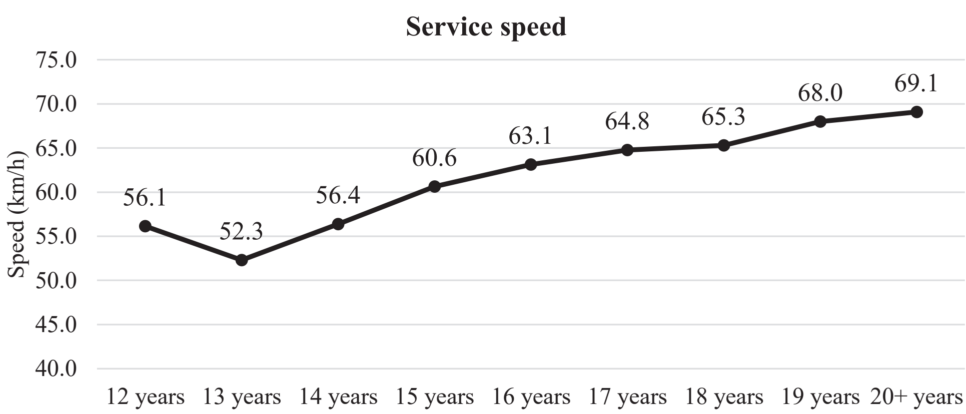

Figure 3. *Age dynamics in the development of speed-power abilities of the upper limbs*

The increase in high jump scores was within 46.2% (25.0 to 32.7 cm) in the CMJ jump, 42.7% (25.0 to 32.3 cm) in the SJ, and 50.2% (29.1 to 37.1 cm) in the CMJA jump. A smooth increase was observed with the increasing age of the competitors, being most significant between 18 and 19 years of age in all three types of jumps; from this age onwards, there was a decrease of 4% again in all jumps. The results of the increase in women are much more diverse; until the age of 18, they fluctuate; after the age of 19, there was a significant increase in the results, with an average of 16% in all jumps.

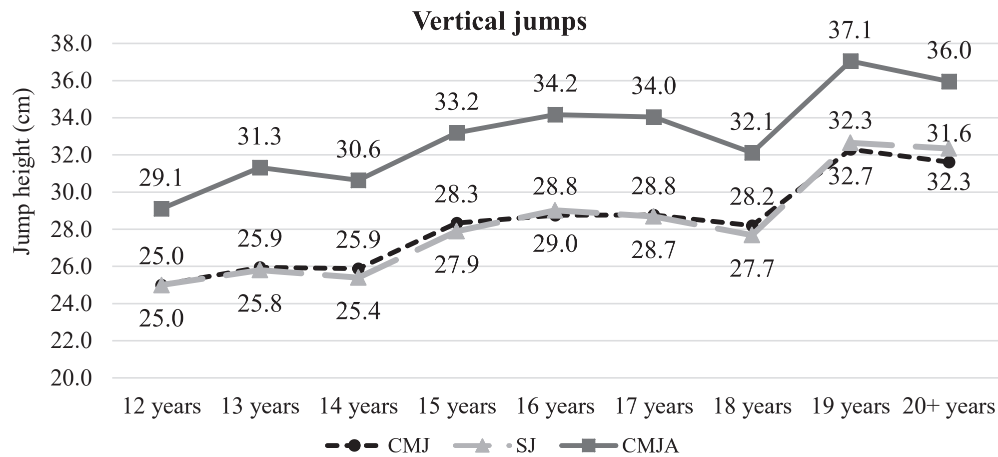

Figure 4. *Age dynamics in the development of the speed-power abilities of the lower limbs*

DISCUSSION

Motor development is defined as changes in motor behavior throughout life (Clark & Whitall, 1989). Malina (2014) defines motor abilities as learning and fine-tuning skillfulness in different physical activities, including individual social and physical contexts (e.g., home, school, community) combined with neuromuscular maturation. Furthermore, Robinson et al. (2015) provide another definition of motor competencies, including motor performance, motor proficiency, motor ability, and motor coordination.

Motor behaviors result from the interactive process between an individual‘s biological limitation and personal circumstances, which is needed to understand the development of motor abilities (Clark, 2005).

Success in sports depends on many factors, such as age, gender, motor abilities, motor qualities, etc. For many decades, researchers highlighted the influence of biological age on functional performance, including motor abilities and qualities (Katzmarzyk et al., 1997; Cabral et al., 2016). According to (Malina et al., 2004), age development is a crucial diagnostic technique to analyze athletes‘ physical potential, motor abilities, and motor qualities. Age development appears to be an essential consideration when selecting an athlete. Therefore, based on talent selection or identification, young athletes with better motor qualities and abilities are more likely to be selected (Gantois et al., 2017).

However, the performance of an early start does not necessarily predict an athlete‘s future success, even though it is important to assess the parameters of young athletes during age development. Methods of evaluation that tend to be used for age development include skeletal age, somatic maturation, and sexual maturation (Gantois et al., 2017). According to (Lloyd et al., 2014), age development can be estimated most accurately using skeletal age estimated by hand radiography. This evaluation method is considered the best assessment for age development. However, some disadvantages are related to high-cost equipment, specialized technicians for radiograph interpretation, and individuals‘ exposure to radiation. Thus, anthropometric parameters are used as an easy method to predict the skeletal age (Cabral et al., 2013). Therefore, this method is efficient for coaches and PE teachers to estimate young athletes' age development.

Monitoring the age development during the young athletes' selection helps to prevent the rejection of a potential athlete who can reach their peers with rapid development in the near future. Thus, the coaches and PE teachers should consider the differences in motor abilities and motor qualities according to age development during young athlete selection or sports orientation process. Identifying how much age development is combined with body size, motor qualities, and motor abilities is essential. This could reduce selection errors in the future when selecting talented young athletes.

Biological maturation has a significant role in motor qualities, motor abilities, and the selection of players. Between the ages of 11 and 14, the progression of motor ability development varies depending on gender: for boys, it occurs mainly between the years of 12 and 13, and for girls between the ages of 11 and 12 (Katic et al., 2013). The dynamics of the development of motor abilities are intense for both genders, but they are different at a certain age. At first, 12-year-old boys develop great psychomotor speed, followed by significant development in all power factors, such as muscle endurance and explosive power to throw and jump. At the age of thirteen, the agility parameters are also developed. Body coordination is completed between 13 and 14 (Katic et al., 2013).

On the other hand, girls have an increase in their flexibility. This is followed by considerable improvements in body coordination, psychomotor speed, especially in the lower extremities, and explosive power in both the upper and lower extremities. All of these changes happen at the age of twelve. Girls start puberty earlier than boys at the age of twelve. The age of 14 is the peak of puberty for boys when boys have greater motor abilities than girls in power, agility, and coordination but not in flexibility.

During adolescence, the biological development rate of persons contributes to changes and differences in body size and physical performance (Beunen et al., 1981; Lefevre et al., 1990), which changes according to gender (Malina et al., 1982; Malina et al., 2004). Age development is correlated with physical performance during adolescence (Malina et al., 2015). Body changes in height and weight through this period of life might be responsible for differences in the performance of motor abilities and motor qualities in young athletes (Till et al., 2014). However, according to (Torres-Unda et al., 2013), many athletes with advanced maturity may be explained by gaps in performance of motor abilities and qualities. However, these differences and gaps are eliminated with age development.

From the point of view of all the considerations mentioned so far for the development of motor abilities, they have to be broken through the specifics of the volleyball game. It consists of the fact that success in volleyball depends on the athlete's ability to jump higher, quickly, and explosively while performing basic motions such as setting, blocking, sprinting, spiking jumps, and serving (Vilamitjana et al., 2008). Before determining how to improve these abilities, it is important to place considerable emphasis on their respective levels through the years of practice (Nurja, 2022). An even more important feature of volleyball is that the requirements for the players' preparation change in different age groups, and their knowledge would help optimize the training process (Serrano et al., 2016).

The final result in volleyball depends on many factors, but conditioning will always remain one of the leading ones, although it does not directly affect the result. Some authors also study the relative age of female competitors as a factor and find no such dependence, which aligns with other studies on the subject (Papadopoulou et al., 2019).

Viewed in another direction, volleyball is a sport extremely dependent on the height of the players, which is determined by the specific rules and the presence of a net between the two halves of the court. From this point of view, the height of volleyball players is a widely researched topic by a number of authors, who determine the height of elite players within 177-184 cm (Fry et al., 1991). In more recent research, the results are even higher (Cosmin et al., 2016). Some authors even conclude that successful volleyball players must be tall, with a high percentage of muscle mass and high anaerobic power (Lidor & Ziv, 2010; Nikolaidis et al., 2012; Schaal et al., 2013). Also, here, we should note that volleyball players in different positions can vary in a large range in terms of height and weight due to some specifics of the playing position, and to a large extent, height determines the height of the rebound (Aouadi & Alanazi, 2015; Nikolaidis et al., 2015). In this study, the data obtained for the height of female athletes is similar to those of other studies. However, we must consider that our approach was not encountered in other studies in which athletes of different ages were grouped into competition categories (Sattler et al., 2012). The data show the fact that during the selection of volleyball players, priority is chosen for players with a higher height than normal for this age of the Bulgarian population based on that of neighboring nations (Nikolaidis et al., 2015; Cosmin et al., 2016; Papadopoulou et al., 2019). In other research, a lower height of female athletes at different ages is noticed (Paz et al., 2016; Pradhar, 2017). The values from Table 1 evidence this. These height changes in age are a positive direction for women to arrive at the values mentioned above.

Women‘s weight in terms of age increases until reaching optimal values for successful implementation in volleyball. The data logically show a normal weight for female volleyball players. A more complete picture could have been obtained if we had studied body fat, which a number of other authors did (Silva et al., 2016). In general, height and weight followed similar growth trends, increasing within about 10%.

Almost every defensive or offensive action requires a certain level of speed ability. From this point of view, it is unthinkable not to use running tests that measure this characteristic of volleyball in an age aspect. The test characterizing speed abilities in volleyball that we have chosen is 20 m running. From a sport-specific point of view, this is not a test that volleyball specialists would choose as the average sprint length in a match is on the order of 5-6 m, but from an anaerobic energy system point of view, it is one that would help us to evaluate it. Other tests that are used in practice vary in range of 5 m to 40 (36.5 m) yard dash (Fry et al., 1991; Gabbett & Georgieff, 2007; Pradhar, 2017; Fuchs et al., 2019; Bunn et al., 2020). These judgments are also evidenced by a number of studies done in volleyball with different age groups and individual genders. In the reviewed literature, we found only one study with the same measured distance, but its results were significantly weaker than ours (average 5.21 seconds). The results gradually improved to have the highest values among the competitors in the women‘s age group. This is due, on the one hand, to the lower fine-coordination capabilities of the young athletes who cope with their increased limb length and, on the other hand, to the still basic level of strength training.

The ability to perform repeated sprint work has not been extensively studied in volleyball but should be due to the intermittent nature of the workload. Research in this direction has been done by some authors (Schaal et al., 2013; Paz et al., 2016; Padhar, 2017). The length of the distance differed from that used in the present study. From this point of view, this study is the only one that shows the age dynamics of these abilities in volleyball.

The vertical jump in the execution of various technical elements in different forms is a basic means of attack and defense in volleyball, which makes it one of the most researched parameters in the scientific literature. This is evidenced by numerous articles by different authors with different age groups in both sexes (Marques et al., 2009; Sheppard et al., 2009; Borràs et al., 2011; Nikolaidis et al., 2012a; Nikolaidis et al., 2012b; Sattler et al., 2012; Schaal et al., 2013; Taware et al., 2013; Nikolaidis et al., 2015; Şimşek et al., 2016; Junior, 2017). In volleyball, jumps are the basis of achieving a win, and every attack ends with them. For this reason, we took and tracked results from three main vertical jumps. From them, we judge the explosive power capabilities of the lower limbs.

Extensive research of the vertical jump height was conducted by Ziv & Lidor (2010), who noted 14 studies related to rebound height in female volleyball players. The tests indicated are very different - SJ, CMJ, CMJA, Abalakov jump, spike jump, block jump, standing block jump, vertical jump with approach, as well as the age and level of the tested persons. The results again do not differ from those obtained in the study and are within 28.5-42.3 cm for the individual jumps (Nikolaidis et al., 2015; Şimşek et al., 2016).

Special interest to conditioning specialists is the lack of difference between SJ and CMJ for almost all age groups, which speaks of the insufficient realization of the maximum possibilities and the weaker level of technical preparation when performing the jumps. Authors such as Şimşek et al. (2016) explain this phenomenon in the following way: (1) unexperienced players cannot transform effective muscles work into effective energy production; (2) muscles are unable to achieve a high level of force prior to the contraction in SJ; (c) during the countermovement before CMJ, muscles are pre-stretched and release their absorbed energy in the jump phase when the muscles act concentrically and can produce more work; (4) the increase of the force and the work available for the concentric phase in CMJ that is lacking during SJ, because of the pre-stretch phase.

The serve is one of the most used technical actions in volleyball, which is the primary means of making it difficult for the opposing team to meet. According to the authors‘ data summarized by Moras et al. (2008), it is believed that the successful serve is not related to the higher speed of the ball, but to the inability to attack unpredictably on the part of the receiving team. Authors such as Marzano-Felisatti et al. (2022) determine that as the players‘ skill increases, the speed of the serve decreases, which is in line with our results when we speak about professional sport. In the same study, the authors note that with increasing age, the number of service errors decreases, and its efficiency increases. However, this pattern needs to be more clearly observed in women. Several authors have researched this direction (Ferri et al., 1995; Forthommeet al., 2005; Palao & Valades, 2009; Singh & Rathore, 2013; Palao, 2014; Fuchs et al., 2019). More specific data are needed on the speed of the ball in terms of age.

Based on all the reasoning up to this point, there are serious gaps in the scientific literature regarding developing anaerobic potential in volleyball players. This can largely be attributed to the change in age groups, from which a larger number of age groups consisting of two ages is noticeable. The only studies in this direction, namely towards creating norms for control and evaluation, have been done by some authors (Singh & Singh, 2018; Bunn et al., 2020). From the results obtained from the research and the use of the Sigma method, we offer the following normative tables for control and assessment of anaerobic potential in women‘s volleyball, presented in tables 5, 6, 7, 8, 9, and 10.

Table 5. *Norms for control and assessment of speed capabilities (sec)*

Scale ⇨	Under recommended		Recommended		Over recommended		Ideal
Limits ⇨ Age group⇩	up	to	up	to	up	to	under
Girls under 14 years	4.14	3.95	3.94	3.54	3.53	3.34	3.33
Girls under 16 years	4.10	3.92	3.91	3.53	3.52	3.34	3.33
Girls under 18 years	4.18	3.94	3.93	3.43	3.42	3.18	3.17
Junior women	4.24	4.00	3.99	3.49	3.48	3.24	3.23
Women	3.81	3.66	3.65	3.33	3.32	3.18	3.17

Table 6. *Norms for control and evaluation of speed endurance (sec)*

Scale ⇨	Under recommended		Recommended		Over recommended		Ideal
Limits ⇨ Age group⇩	up	to	up	to	up	to	under
Girls under 14 years	21.19	19.84	19.83	17.12	17.11	15.76	15.75
Girls under 16 years	20.54	19.39	19.38	17.05	17.04	15.89	15.88
Girls under 18 years	20.34	19.23	19.22	16.98	16.97	15.85	15.84
Junior women	19.99	19.08	19.07	17.24	17.23	16.32	16.31
Women	19.23	18.25	18.24	16.26	16.25	15.26	15.25

Table 7. *Norms for control and evaluation of the speed-power abilities of the upper limb (km/h)*

Scale ⇨	Under recommended		Recommended		Over recommended		Ideal
Limits ⇨ Age group⇩	up	to	up	to	up	to	Over
Girls under 14 years	34	42	43	63	63	72	72
Girls under 16 years	40	48	49	67	68	76	76
Girls under 18 years	49	55	56	71	72	79	79
Junior women	52	58	59	72	73	79	79
Women	58	63	64	75	76	80	80

Table 8. *Norms for control and evaluation of the speed-power abilities of the lower limb SJ (cm)*

Scale ⇨	Under recommended		Recommended		Over recommended		Ideal
Limits ⇨ Age group⇩	up	to	up	to	up	to	Over
Girls under 14 years	18.1	21.8	21.9	29.5	29.5	33.3	33.3
Girls under 16 years	17.1	21.7	21.8	31.3	36.0	36.0	36.0
Girls under 18 years	18.7	23.8	23.9	33.9	39.0	39.0	39.0
Junior women	17.1	22.7	22.8	33.9	39.5	39.5	39.5
Women	26.3	29.3	29.4	35.3	38.3	38.4	38.4

Table 9. *Norms for control and evaluation of the speed-force abilities of the lower limb CMJ (cm)*

Scale ⇨	Under recommended		Recommended		Over recommended		Ideal
Limits ⇨ Age group⇩	up	to	up	to	up	to	Over
Girls under 14 years	17.8	21.8	21.9	29.8	29.9	33.8	33.9
Girls under 16 years	17.2	22.1	22.2	31.9	32.0	36.8	36.8
Girls under 18 years	18.3	23.5	23.6	34.0	34.1	39.2	39.2
Junior women	17.6	23.1	23.2	34.2	34.3	39.8	39.8
Women	24.3	27.9	28.0	35.2	35.3	39.0	39.0

Table 10. *Norms for control and assessment of speed-force abilities of the lower limb by CMJA (cm)*

Scale ⇨	Under recommended		Recommended		Over recommended		Ideal
Limits ⇨ Age group⇩	up	to	up	to	up	to	Over
Girls under 14 years	22.4	26.7	26.8	35.2	35.3	39.5	39.6
Girls under 16 years	20.4	26.1	26.2	37.5	37.6	43.2	43.2
Girls under 18 years	23.1	28.5	28.6	39.6	39.7	45.2	45.2
Junior women	19.9	26.3	26.4	39.1	39.2	45.4	45.4
Women	28.7	32.3	32.4	39.6	39.7	43.2	43.2

CONCLUSIONS

Through this study, analyses of the development in the age aspect of signs characterizing the anaerobic potential in volleyball players have been made. For the entire study period, an increase was observed in all the investigated indicators, with the most significant increase noted in the explosive power abilities of the lower limbs, followed by the upper limbs. The most pronounced increase in all indicators is observed between the ages of 13 and 14 and 19 and 20 years. At the same time, a poor realization of the explosive power abilities of the lower extremities without using the hands is noticed.

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