BABEȘ-BOLYAI UNIVERSITY CLUJ-NAPOCA

FACULTY OF PHYSICAL EDUCATION AND SPORT

DOCTORAL SCHOOL

Stupar Radu-Cristian

PHD THESIS

Summary

PhD coordinator:
PROF. UNIV. DR. MONEA GHEORGHE

Cluj-Napoca
2022

BABEȘ-BOLYAI UNIVERSITY CLUJ-NAPOCA

FACULTY OF PHYSICAL EDUCATION AND SPORT

DOCTORAL SCHOOL

Stupar Radu-Cristian

Optimization of the attack in junior volleyball players by implementing the one-legged attack

PhD coordinator:
PROF. UNIV. DR. MONEA GHEORGHE

Cluj-Napoca
2022

CONTENTS

KEYWORDS: volleyball, attack, vertical jump, plyometric exercises, periodization, model, efficiency quotient, physical training.

INTRODUCTION

Volleyball belongs to the category of team sports. It is a game with an excellent public appeal due to the emotional content it offers, the boosting of the players' creative capacity, and the character of total involvement in the battle, regardless of the score (Mureșan, 2005).

Emerging as an alternative to the game of basketball, it became trendy among young players, as at that time, the known games were football, rugby, handball, and tennis (Volleyball, 2015). In the current era, volleyball is defined by the speed and diversity of actions and the constant refinement of these actions. An ever-increasing point of hitting the ball, ingenuity in forming attacking combinations, and flexibility in selecting defensive systems characterize, according to Barzouka, Sotiropoulos, Drikos, Kitsiou, and Angelonidis (2021), the modern volleyball game.

Vuorinen (2018) considers that one of the essential characteristics of the volleyball game is the ability to spread the best ideas and strategies through imitation, from one team to another or from one player to another. Essentially, the moment someone invents something new and effective, it slowly populates everywhere, with the caveat that these changes know the possibility of implementation over a long period.

At the high-performance level, we are witnessing an acceleration in the pace of the phases of play, an increase in the number of simulations in the offensive stages, and a change in the distribution of attacking actions. These increase the degree of uncertainty and prevent the efficient organization of the opposing team's blocking (Barzouka et al., 2021).

This paper aims to introduce a new orientation in junior volleyball players' technical-tactical and physical training process by implementing a training program designed to achieve the point and win the service.

Further, being concerned with this sport, I have shown an interest in learning about the aspects related to the completion of the attack with a foot release, which led to the choice of the current topic. After studying the literature, we found a use of the one-legged jumps to finish the attack in women's volleyball both at the international and national level, especially by center players. Due to the distribution of passes mainly on the net, thus prefer their transmission towards the extremes, making it difficult for a central player to move and block.

The procedure mentioned above is effective as long as it is technically and correctly used. Therefore, the one-legged jump attack should be studied primarily in women's volleyball. It proves its effectiveness by the possibility of "opening" the game, its advantage being linked

to its increased speed of execution and the reduced probability of reading and anticipating the player's direction.

By introducing this process in men's volleyball, the junior category will try to capitalize and revive it to obtain a superior vertical separation, leading to easy winning points and service. A higher jump gives the player a better angle of attack and the time needed to decide whether to force an attack or place the ball to avoid the opposing team's block.

A new approach to this process applied in men's volleyball could have an increased impact on the actual conditions of the game. Additional knowledge about the characteristics of the one-legged drop attack in men's volleyball would contribute to a complete understanding of its performance.

Therefore, learning additional information about new ways to carry out offensive phases could provide more effective measures for mitigating or even eliminating adversarial defensive tactics. In this sense, realizing the one-legged release attack in men's volleyball could give an element of great interest that can profoundly improve the performance of offensive actions, becoming a success factor of offensive tactics.

The present research aims to choose a training plan to lead junior volleyball players to achieve superior vertical heights by identifying some critical aspects of using vertical jumps on one leg.

It is assumed that implementing a technical and physical training plan adapted to the specifics of the volleyball game, which aims to use the release of a foot from the offset, will try to achieve better results in the offensive phases. Three studies were conducted on different aspects of one-legged vertical jump performance to address this aim and achieve a more contextual approach.

In the first study, we analyzed vertical release modes and their efficiency, highlighting the importance of jumping ability depending on the sport practiced. The second study aimed at verifying the relationship between vertical jump on one leg and vertical jump on both legs concerning the height of the maximum point reached. Subsequently, the third study aimed to clarify whether the one-legged vertical jump would lead to superior height performance and attack accuracy quality in players on the net.

The main argument for the choice of this theme lies in using the one-legged jump as an alternative method to complete the attack and score points in men's volleyball, to obtain a superior vertical jump, avoid the opponent's block, and win in the end.

In our opinion, the one-legged attack can help the men's volleyball game with tactical combinations designed to mislead the opposing defense. Thus, by this procedure, the attacking

player could be left with only one man at the block, as is often seen in women's volleyball, where the middle player acts on the ball sent backward with a medium trajectory between zones.

This paper is divided into three parts and eight chapters. The first part of the paper presents the theoretical background. Then, it covers information from the literature on vertical release, age and training characteristics of junior players, sports form and planning in the game of volleyball, and training modeling.

Part two of the paper presents the approaches and results obtained in the preliminary research. To this part correspond two preliminary studies which aimed, in the first instance, to highlight the vertical disengagement capacity between three different categories of athletes. These athletes used single-leg and double-leg jump as their primary way of jumping.

The first preliminary study aimed to highlight the differences between the two types of the jump to decide on the optimal procedure. The second study reports the ability of volleyball players to use the one-legged vertical release following movement as an alternative way to initiate offensive attacking phases.

The third part of the paper presents the implementation of the intervention program to improve the vertical clearance values, with the finality of influencing the performance level of the athletes involved. The intervention plan aimed at comparing two research groups following the application of the methodology developed to optimize the performance capacity of the athletes. This study was carried out during a competition season.

The research study was conducted with volleyball players, juniors, and members of county school sports clubs. Therefore, the results of the intervention plan presented in this thesis should be attributed to this age group only.

PART I

THEORETICAL AND SCIENTIFIC BASIS OF THE WORK

SUMMARY OF CHAPTER I

GENERAL INFORMATION ON VERTICAL JUMP IN VOLLEYBALL

In volleyball, the high jump is expressed by combining two motor qualities: strength and muscle elasticity (Hantău, 2007; Pereira, de Freitas, Rodacki, Ugrinowitsch, Fowler, and Kokubun, 2009). Pereira et al. (2009) consider that detent is used in the rapid attainment of maximum force, within a movement, by exerting high acceleration on a mass.

Petrigna et al. (2019) consider the ability to jump an essential basic requirement of a volleyball player to execute different game-specific actions such as the jump pass, jump serve, attack and block. In recent times, the evolution of the volleyball game highlights the importance of increased vertical clearance rates in achieving superior results. Two other attributes are involved as a combined motor quality; the factors influencing the two motor qualities will also influence vertical jump.

In our opinion, these factors are age, gender, muscle fiber thickness, the level at which training begins, continuity of the training process, and ability to concentrate.

Vertical release height, according to (Baker, 2014; Ficklin, Lund, and Schipper, 2014), is influenced by the efficient use of arm swing, with 30-40% of the release height due to better use of elastic energy, but also by the specific composition of the muscle fibers.

In volleyball, vertical jump is most commonly found in attacking and blocking actions. Depending on the characteristics of the movement and of the hit, it takes the following forms: double-legged spike, single-legged spike and double-legged spike. Of these, we will now look at vertical jump of one-legged.

To better know what the one-legged strike is, first, we need to understand what the strike for attack means. In the Rules of Volleyball approved by the FIVB in 2012 the attack shot is defined as the action that directs the ball into the opponent's playing space, excluding the serve and block.

The single-leg jump attack can be performed from in front of the lifter, behind the lifter or from the side. It is used with good results when the player's movement is parallel or slightly oblique to the plane of the net and the completion of the individual offensive action takes place between adjacent areas.

According to (Klavora, 2000; Tudor, 2005), measurement means comparing a given quantity with a standard quantity and specifying the difference between it and the standard quantity, specifying how much or how many times it is greater or smaller than the usual

quantity. In performance and high performance sport, the assessment of subjects' performance has acquired particular significance (Klavora, 2000; Tudor, 2005).

The same authors point out that stakeholders need to capture all the aspects that arise in carrying out these activities. Thus, in the field of motor activities, measurement is presented in various particular elements, and is encountered in the areas of research and teaching and learning in order to follow the development of somatic factors or motor aspects. Sports activities are increasingly influenced by decisions based on quantitative information, and measurement is the primary source of this.

According to Sattler, Sekulic, Hadzic, Uljevic and Dervisevic (2011) vertical jump performance can be measured by a variety of modalities, from the more sophisticated, such as platform jumps, jump mats, to those readily available, such as the Sargent test.

Sattler, Sekulic, Hadzic, Uljevic and Dervisevic (2012) consider that in volleyball there are several specific moves associated with vertical release: the jump to block and the release move to attack.

According to Luis (2000) traditionally, the Sargent test is also the most commonly used method to measure vertical jump, as it is simple and does not require a lot of materials to implement. Basically, it involves measuring the difference between the height with the outstretched arm and the height of the maximum point reached following a vertical jump from the site.

Borges et.al (2017) consider that in order to be able to evaluate the players of a volleyball team, it is necessary to be able to transport the equipment to the training site, taking into account that volleyball players usually train on the court, in relatively large numbers, and transporting all participants to a laboratory would be impossible and very expensive.

Alanen, Räisänen, Benson and Pasanen (2021) consider that a solution for measuring biomechanical patterns during athletes' activity would be the Vert mobile device, as it can provide real-time information related to the quality of specific movements or executions in order to improve performance.

Taylor, Cohen, Voss and Sandercock (2010) argue that volleyball is a sport based on fast explosive movements with a concise time of occurrence, in which vertical release is an essential component in both attacking and defensive phases.

In this sense Cojocaru and Cojocaru (2019) state that the development of vertical jump is a significant objective in the game of volleyball, because it is an essential quality for all players and thanks to plyometrics it receives a substantial effect in increasing power and developing specific muscle fibers.

Suresh, Begum, Meeran, Sivakumar and Pharma Int, Sci Bio (2017) point out that movements performed at speed and changes in direction specific to the game of volleyball must be trained to produce the explosive force that is required for full performance. These types of movements are characterized by muscle stretching and shortening phases, which are the basis of plyometric training. It's a method used since ancient times to help athletes run faster, jump higher and throw farther.

According to Soundara and Pushparajan (2010) plyometric training includes exercises that make muscles capable of reaching maximum strength in the shortest possible time. To achieve these goals, strength is essential.

Mirela, Raducu, Antoanela, Carmen and Giurgiu (2014) state that plyometrics serves to rapidly mobilize increased innervation activities; increase the frequency of impulse release in explosive power; develop the nervous system to react with maximum speed to muscle lengthening, which produces a faster contraction with full force.

The fundamental principle of plyometrics lies in the rapidity of the change between the two types of contractions, the secret of this change lies in the transition from a state of lengthening to a form of shortening as recalled by Polakovičová, Vavák, Ollé, Lehnert and Sigmund (2018). Plyometric training is aimed primarily at developing strength in both the lower and upper limbs.

According to Dolati, Ghazalian and Abednatanzi (2017) TRX training was established in 1990 under the name of general strength development training and is recognized as a current modality used in the exercise of performance and high performance athletes.

It is considered by Ide, Silvatti, Marocolo, Santos, Da Silva, Oranchuk and Mota (2021) to be a new training concept, falling under the category of functional training and originally appearing in the fitness world, it has become a very effective way to improve sports performance.

Dolati et. al. (2017) state that TRX training is a unique modality that uses one's own body weight as resistance with positive effects on the human body by strengthening muscles, increasing joint stability and strengthening ligaments.

Taking into account all the opinions of the aforementioned authors, we recognize the increased effectiveness of functional training, performed with the TRX device, in terms of developing lower limb muscles and increasing their stabilization.

SUMMARY OF CHAPTER II

AGE AND TRAINING CHARACTERISTICS OF JUNIOR VOLLEYBALL PLAYERS

Palao, Manzanares and Valadés (2014) consider that sports performance depends on the combination of tactical, technical, mental and physical, as well as anthropometric indices. In the game of volleyball, anthropometric index are fundamental due to the existence of an obstacle, namely the net, which is at a height of 2.43 meters and can only be overcome by a high vertical clearance.

In this regard, Toselli and Campa (2018) present the anthropometric values for the athletes they researched, aged 15 to 16, in the following manner. For the zone 4 player they issue the following values: height 193.81 cm, torso height from sitting 57.11 cm, body weight 90.74 kg, body mass index 24.17, lower limb length 136.70 cm.

Following (Baker, 2003; Baker, Cobley and Fraser-Thomas, 2009), the anthropometric values of the centre player are as follows: height 202.30 cm, torso height from sitting 60.96 cm, body weight 93.22 kg, lower limb length 141.34 cm and body mass index of 22.77. With regard to the universal shooter, the anthropometric parameters listed are as follows: height 202.77 cm, torso height from sitting 60.63 cm, length of lower limbs 142.14 cm, body weight 96.26 kg and body mass index 23.37.

Karahan (2011) states that maximal aerobic power is manifested between the ages of 12 and 16 during adolescence, with improved indices during puberty. The same author argues that explosive power, jumping skills and speed develop between the ages of 14-16 and especially during puberty. The development of motor skills and physical preparation specific to the game will be addressed in terms of a multilateral physical practice.

Cojocaru and Cojocaru (2018) consider that at this age group, players must be able to perform: the forward dig, the forward attack - the return procedure, the overhead set from the jump, two-handed up and down passes, the two-handed block, placing the ball with one or both hands.

According to Poenaru (2006) the content of training for 15-16 year olds is focused on harmonious physical development, which consists of toning the muscle chains involved in the actions of the game, stimulating the capacity for specific effort, preparing the segments of primary importance and joint mobility.

The ability of players in this age group as Cojocaru and Cojocaru, (2018) recall includes: the ability to make the sideline pass, one-handed jump pass, simulated offensive shot and jump pass, three-player block and self-double.

According to Moșneag and Mureșan (2004) the content of training is based on harmonious physical development which aims to achieve an optimal weight ratio, active mass and adipose tissue, functional support for specific effort, muscular elasticity and joint mobility.

According to Moșneag and Mureșan, (2004) the training process should lead the athlete through several stages of training, from initiation to performance, with precise tasks to facilitate learning, refinement and automation.

Roman et. al. (2017) susțin faptul că participanților le este solicitat în cadrul jocului de volei o pregătire fizică corespunzătoare, iar pentru dezvoltarea valorică a jucătorilor este necesară și pregătirea segmentelor solicitate.

According to (Mureșan, 2005; Mroczek, Superlak, Kawczyński and Chmura, 2017) the basis of a volleyball player's training is the development of motor skills, by solving specific tasks in the attack and defence phases. The general physical activity of volleyball players is carried out by means of exercises of a general nature, but also by means of activities borrowed from other sports. As for the development of combined motor skills, according to Mureșan (2005), this can be developed without the use of special apparatus, only exercises without a ball and exercises with a ball are necessary.

Savu and Pehoiu (2018) mention that speed is a paramount motor quality in the game of volleyball, manifesting itself in a wide range of forms, from the simplest to the most complex.

The manifestation of these forms in the volleyball game is explained by Soundara and Pushparajan (2010) and translates into the players' ability to perform changes of direction with speed.

The most important factors that determine speed are: the mobility of the unfolding of the fundamental nervous processes, the rate of conduction of the nervous influx, the speed of response of the muscle to the nervous excitation, the length of the segments engaged in the movement and the type of fibre of which the force is composed (Kinetic, 2017).

For the development of speed in volleyball training, (Mureșan, 2005; Cojocaru and Cojocaru, 2015) propose the following methods: the alternative method, the repetition method and the competition method. For the development of reaction and execution speed, Mureșan (2005) proposes: exercises without the ball - jumping in all directions, quick changes of positions and orientations to auditory and visual signals; activities with the ball - throwing and

passing in the form of a race, catching and retrieving the ball rebounded from the wall, dynamic games.

In volleyball training, to develop speed in its various forms of manifestation, exercises with a small number of repetitions are used, but executed at maximum speed, with long pauses, in which light specific and non-specific relaxation exercises are introduced according to the authors Soundara and Pushparajan (2010). Through training, coordination processes influence the learning and improvement of specific motor acts, with a decisive role in the formation and advancement of new skills. Thus, an athlete with well-developed coordination skills will be able to master technical elements more easily.

Thanks to the fact that the actions in volleyball are generally random, in order to facilitate learning, the simplest forms of teaching are used, divided into clear segments with logical sequence according to the author Reynaud (2011). To enable athletes to adapt their performance in order to cope with complex competitive situations, the technique of the volleyball game must be constantly developed. Acquiring a high level of technical elements is fundamental, provided athletes learn the tactics of volleyball as Gamaliy and Shlonska (2016) point out.

The improvement of technique and tactics relies not only on the coach's knowledge, but also on the athlete's ability to master certain elements. The athlete's ability to learn depends on their ability to process new information, based on previous patterns and individual motor skills.

According to Lungu (2015), the leading tactical element of the strategy in the offensive phases is the attack. The same author states that a player positioned in the front line can take an attacking kick at any height, being obliged to make contact with the ball in his own half.

SUMMARY OF CHAPTER III

PARTICULARITIES OF THE PERIODIZATION OF THE COACH IN JUNIOR VOLLEYBALL

As Platoniv, (2015) states, athletes develop and refine their functions progressively over a long period of time. Therefore, maintaining a high level of adaptive responses in modern sport over a more extended period of time has as its primary purpose, the maintenance of sport performance at a maximum accessible level and is characteristic for the final stages of the annual training, as Platoniv (2015) indicates.

Any increase in effort in the training of athletes must be followed by an unloading phase, during which the level of activity is decreased according to Bompa (2003).

Bompa (2003) also argues that the physiological base of the volleyball player must be developed during the training and development phase, which is designed according to the competitive needs. Thus, for the game of volleyball only one competitive step is used, in which there is only one peak of form. Such a plan is called a monocycle and is divided into preparatory, competitive and transition phases.

The authors Lyakh, Mikolajec, Bujas and Litkowycz (2014) argue that the goals aim to develop the type of sport-specific strength that the player needs to optimise their performance. The principle of this period is the involvement of most muscle groups, preparing muscles, ligaments and tendons for the following phases of training and demand.

By Lyakh et. al. (2014) the goals of endurance staging aim to develop endurance in three phases: anaerobic, aerobic and specific, using an annual plan with a single peak.

Cissik, Hedrick and Barnes (2008) argue that staging strength begins early in the season with a focus on aerobic strength development through high-volume, low-intensity training, gradually progressing to lower-volume, high-intensity workout.

According to the authors Lyakh et. al. (2014), speed staging depends on the characteristics of the sport, the level of performance and the competitive program. The training of athletes in team sports differs from that of athletes in individual sports.

According to the authors Ohuruogu, Jonathan and Ikechukwu (2016) in the literature, the notion of fitness has been replaced by that of sports fitness or peak training condition and represents, the main goal to be achieved through the sports training process. It occupies a central place, given that it acts as the primary goal. The ways of assessing athletic fitness are given by factors that attest to: excellent health, superior results obtained in competitions and control tests,

higher values of functional indices, a remarkable ability to recover according to Sian and Hopkins, (2014).

Hartmann, Wirth, Keiner, Mickel, Sander and Szilvas (2015) state that the manifestation of athletic fitness can vary from a few days to a week or more, after which loss of muscular fitness definitely follows, if training has been approached correctly. The evolution towards the peak of athletic form during an annual plan is the result of organised, systematic training, in which the athlete's effort capacity, the acquisition of skills and tactical procedures reach high levels.

Periodisation is one of the most important concepts of training and planning and refers to two essential aspects of athlete training: 1. Periodisation of the annual plan (its primary purpose is to divide the whole year into more minor training phases, thus facilitating the planning and implementation of the training programme) and 2. The sequencing of motor skill development phases (refers to the prioritisation of training phases to lead to higher indices of speed, strength, endurance and skill).

Mazon, Gastaldi, Sacco, Cozza, Veloso and Souza (2011) highlight the following aspects of the typical periodization of sportsmanship in the game of volleyball, dividing them into three essential stages: 1. Preparatory or preparation of children with special skills; 2. Competitive practice or training of high-performance athletes; 3. Transition stage. The same authors argue that the traditional periodisation model has several limitations in the structure of athlete training, due to the large number of competitions leading to inconsistent training periods.

Garganta (2007) considers that the forward-looking training of children with outstanding skills makes them future candidates for Olympic and world medals. Training high-performance athletes for participation in high-profile competitions requires a great deal of training, which takes between three and seven years. The development of fitness in this category takes on a different and complex configuration, due to the movement of athletes in their respective clubs and national teams.

In terms of the training of athletes participating in domestic competitive activities, the acquisition of sportsmanship at this stage includes a finite number of athletes. The timing of the movement is carried out according to the competition calendar, respecting the characteristics of the effort specific to the branch of sport.

The objectives of this period are represented by the increase of morpho-functional possibilities and physical qualities, the enrichment of the baggage of skills and basic motor skills and, last but not least, the conclusion of the collective and the installation of a climate of work and discipline as indicated by Mureșan (2004).

As far as specific training is concerned, the objectives of this period are to get fit. The dynamics of the effort that characterise this period involve measures that gradually increase in intensity by abandoning general exercises and replacing them with specific activities.

According to Moșneag and Mureșan (2004), the majority of specific training is carried out both on the basis of standardised technical-tactical methods and on the basis of special exercises for each component, the proportion of which is gradually reduced.

Ohuruogu, Jonathan, and Ikechukwu (2016) argue that participation during a competitive year in competitions is given a preparatory and verification character, which will help to guide the whole training system, thus raising the level of effectiveness of dominant playing actions according to position specialization.

Cissik, Hedrick, and Barnes (2008) consider that the competitive phase is followed by the active rest phase, during which the intensity decreases and the athletes' preparation reaches an almost recreational level. This is generally achieved by means specific to other sports.

Cissik et al. (2008) believe that in this stage, the content phasing aims to develop speed and detent endurance, increase strength and speed indexes, and maintain aerobic endurance.

SUMMARY OF CHAPTER IV

PATTERNS AND MODELLING IN THE GAME OF VOLLEYBALL

Modeling involves, first of all, developing a model. According to Turner et al. (2019), in mathematical logic, modeling involves correctly interpreting a formal system or adding new axioms to a given system of axioms.

The modeling components of possible annual training and competition model for a volleyball team at the club level are

- the model of player selection;
- the model of team play on the six positions, with efficiency coefficients;
- The training model on technical-tactical, physical, psychological, and theoretical components and the model of the sports calendar with its objectives.

Stöckl et al. (2017) state that the model in the game of volleyball must always be conceived as practically feasible, and for its indicative establishment, it is necessary for the coach to know the play of the opposing teams, the possibilities of his team and to be up to date with all the news in the field.

Through the team and players' game model, Moșneag and Mureșan (2004) understand the concrete and whole way their game is to be played at a given moment in a competition. The game model appears as a whole that allows us to evaluate and compare the content of the game with that of the top teams in international championships. It is evaluated in terms of the essential elements and the development and direction of the volleyball game.

According to Hileno, Arasanz, and García-de-Alcaraz (2020), the known game complexes are the KI complex, which starts with the reception of the service and continues with the construction of the attack. The pattern at the winning point, also known as the II complex or side-out transition, comprises the totality of defensive and counterattacking actions.

Hileno et al. (2020) find that the two complexes are considered obsolete because they can only analyze aspects related to receiving from and obtaining points from the service. On the other hand, recent studies by Loureiro, Hurst, Valongo, Nikolaidis, Laporta, and Afonso (2017) highlight the existence of six-game complexes. Four new complexes, complementing the two existing ones, were recorded as K0, KIII, KIV, and KV.

In addition to the known variables in the game, the researchers Hileno et al. (2020) found it necessary to add new variables in the game phases. These variables are the type of serve, the area in which the serve was performed, the area in which the opposing team made

the reception, the area in which the ball was set for an attack, and the number of players available for attack.

Below, we detail the characteristics of each of the complexes as mentioned above:

The K0 complex has been given the service name and is represented by the situation where the game phase no longer continues.

According to the findings of Hileno and Busca (2012), complexes III, IV, and V are based on defensive actions at the ground or net, doubling the attack, blocking, and reorganizing the counterattack on the recovered ball.

The KIII complex represents the game situation that does not allow the construction of the offensive phase of play to become the phase of play completed by the attack. Instead, it can end with the ball being recovered by the opposing team.

The KIV complex is where the phase of play is completed by attack or counter-attack. However, the construction of the attack is disorganized, and the ball is passed for attack by another player, different from the coordinating player.

The KV complex allows offensive phases to be completed by attack or counter-attack, followed by a reorganization of the defense when the opponent attacks. This situation allows the shooting player to execute an attacking shot from the second ball or to help construct an offensive phase in the best conditions for the other teammates.

The main objective of intermediate model 3 (15-16 years) is to strengthen the play actions in the context of the dominant morpho-functional and psychological capacities. The training objective is to specialize the first-line players and the second-line setter. The playing systems frequently used in this model are four attackers and two setters or five attackers and one setter.

According to Cojocaru, Lăzărescu, and Ștefănescu (2013), the primary offensive system used is five attackers + one setter.

According to Cojocaru et al. (2013), the intermediate 4 model (advanced 17-18 years old) involves the specialization of the player's buy zone in the first and second line. The offensive system consists of five attackers + one setter. As basic actions, the organization of attacking phases, for this model is carried out with the entry of the coordinating player from all zones at the reception from the service.

The attack is combinatory, only with the players in the front line, the direction of movement, and the return, with placing or fake attack.

The functional model of the coordinating player must have an excellent knowledge of the game and possess outstanding mental qualities. They must also be able to think quickly, be highly competitive and have self-control in difficult situations during the game. Another quality of a coordinator is that of a leader, responsible for the cohesion and harmony of the team.

The functional model of the Zone 2 player, also called the universal striker, participates in an average of 110-118 game actions, of which 72 are ball actions. Of these, the authors Moșneag and Mureșan (2004) pointed out that his defensive actions at the net account for 23%, offensive actions account for 23%, taking from serving 18%, taking from attack 18%, serving 13%, and passing or passing the ball 5%.

This player is used in the five attackers + one setter system of play, being the correspondent of the point guard, with the task of passing the ball in situations where the point guard does not have this possibility.

The functional model of the zone 3 player is a player who permanently plays in zone 3 with balanced participation in all game actions. Besides being a good offensive player on the front line, he must also be an excellent defensive player. On average, his involvement in the volleyball game is 98-106 actions/set, of which 64 are ball actions as recalled by (Moșneag and Mureșan, 2004; Reynaud, 2015; Cojocaru and Cojocaru, 2018; Lima, Palao, Moreira and Clemente, 2019).

The functional model of the player in zone 4, also called the second striker, with an average of 105-112 game actions/set, of which 66 with the ball, according to the findings (Moșneag and Mureșan, 2004; Lima et al., 2019;). The same authors consider him the player with the most actions in a team, which is why he is also called the force player. From the 66 actions with the ball, the authors mentioned above distinguish the following percentage representations: involvement in attacking actions - 30%; involvement in blocking actions - 19%, taking from service - 19%, taking from attack - 17%, and service - 15%.

Within the modern methodology of acting and directing athletes' training, the authors (Lungu, 2015; Hileno, Arasanz, and García-de-Alcaraz, 2020) point out that significant changes have occurred, and the game of volleyball has not been neglected in this respect. This discipline requires technical, tactical, and physical training at a high level. Therefore, improved physical preparation has significant implications in this sport, with players performing many explosive moves.

According to Serban (2009), volleyball is characterized by a rapid change in the character of the movement. For this reason, volleyball players must develop motor skills, speed of movement and reaction, and resistance to physical and mental tasks, whose intensity and

volume alternate. It is well known that the ability to jump as high as possible and to reach the maximum point in the shortest time are some of the goals of a volleyball player. This characteristic ensures success in both offensive and defensive phases.

According to Imas, Borysova, Shlonska, Kogut, Marynych, and Kostyukevich (2017), the training of volleyball players is based on the team's playing pattern and knowledge of the effectiveness of technical-tactical actions, all of which result from the processing of recordings. The same authors argue that it is crucial to know the volleyball game's structure to model its specific actions and set training priorities.

The training model for a competitive year contains intermediate models, divided into periods and stages with staggered content, specific means, specific methods, and intermediate and final control tests. The technical-tactical ability of the advanced group in the training and checking must be determined by the execution of isolated playing actions on the service and taking over from the service.

The physical component has the following objectives: increase the effort capacity achieved within the team; recovery, and recuperation at the end of the competitive period, based on active rest and recovery.

Trninić et al. (2009) argue that the training of the advanced group represents a qualitatively superior stage, based on the knowledge acquired during the previous stages of training, with the specification that it must ensure continuity of training towards high performance.

The advanced group's performance objectives aim to prepare and individualize players with prospects by adopting individual methodical measures designed to achieve a high level of preparation.

According to Mureșan (2004), the psycho-theoretical component ensures the players' adaptation to the possible situations in the next game and is as essential as the other components.

SUMMARY OF CHAPTER V

CONCLUSIONS FROM THE LITERATURE REVIEW

The vertical release is considered an essential basic requirement of a volleyball player in order to be able to execute various game-specific actions such as the jump pass, jump serve, attack and block.

In the game of volleyball, dexterity is expressed by combining two motor qualities: strength and speed and muscular elasticity. In order to able to achieve superior vertical release values, volleyball players need to be constantly concerned with their physical training and the development of strength in all its forms. The primary purpose of the one-legged release attack is to defeat the opposing player responsible for the block. Therefore, the basis of a volleyball player's training is the development of motor skills, within the game, by solving tasks specific to the attacking and defending phases.

The training is based on harmonious physical development to achieve an optimal weight ratio, active mass and adipose tissue, functional support for the specific effort, muscular elasticity, and joint mobility. The training of volleyball players requires different exercises and training regimes that address the whole body, the main feature being the training of the lower body, considering that jumping is the key to success;

By combining strength training with weights and plyometrics, strength in the lower limbs is most easily developed, and superior vertical release results are achieved. Athletic form corresponds to the graphic vision we give to the final training goals and is considered the upper step of the training grade. The establishment of sports form depends on how the training is directed and is achieved gradually over the three training periods. Periodization of training is the division of an entire competitive season into smaller training periods and training units;

Modeling involves the development of a model and is a method of studying objects and phenomena used to provide the specific information needed. The preparation of matches and the establishment of the game model for each match is achieved by mobilizing the players physically and mentally to high levels;

The phenomenon we studied represents only a tiny part of volleyball's physical and technical-tactical manifestations. Therefore, we did not proceed with the research only after investigating the information in the literature corresponding to the research topic.

PART II

PRELIMINARY RESEARCH

SUMMARY OF CHAPTER VI - PRELIMINARY STUDY I *STUDIU COMPARISON OF VERTICAL JUMPING ABILITY IN ATHLETICS AND SPORTS GAMES ATHLETES*

The second part of the paper includes research on vertical disengagement's ability. In the first study, we analyzed athletes using the one-legged release and the two-legged release as their jumping mode.

The objectives of the preliminary study were: to make the organizational plan and establish the necessary groups, select and apply the tests necessary to start the research, centralize and interpret the data obtained, and analyze the data resulting from the application of the tests.

From 09.08.2019 to 14.08.2019, the research started with the testing of three different categories of athletes who use both single-leg and double-leg vertical jumps by the nature of their sport.

The starting point of this study was to demonstrate that the height achieved with a one-legged vertical dismount is superior to that with a two-legged vertical jump.

The preliminary study aimed to select and apply control samples to determine the most effective type of vertical separation.

To this end, we formulated the following hypotheses:

I_1 Athletes who use as their primary way of jumping, the vertical jump on one leg of the height, will achieve higher compared with the vertical jump on both feet;

I_2 Athletes who perform the one-legged vertical jump from a different branch of sport may differ;

I_3 Athletes who perform the vertical jump on both legs should not differ between the individually measured lower limbs.

The participants included in the research study were six in each group involved. Before starting testing, candidates were informed about the tasks to be performed, and the anonymity of data use. The research took place both in the Sports Hall of Dej and in the sports hall of the Sports High School of Cluj-Napoca.

In this study, we considered it favorable to use the following main methods: the conversation method, with the help of which we explained to the participants what they had to perform; the observation method, utilizing which we observed the behavior of the athletes in performing the tasks; the test method, which contributed to the evaluation of the athletes' ability

to jump higher from the spot and out of the movement. Last but not least, the statistical method was used to highlight the differences between the three groups and between their means.

The apparatus used in Preliminary Study I involved using the G-Vert device, a device with increased reliability, which allows accurate recording of vertical separation. In addition, through the VERT mobile app, measurements become available in real-time and on myvert.com.

In order to record and highlight the differences between the three categories of athletes in Preliminary Research Study I, participants were assessed using the following tests:

T1. - AVJ. - Approach Vertical Jump - Vertical jump, from movement, reaching the maximum point, with one hand.

T2. - SVJ. Standing Vertical Jump - Vertical jump, from a standing position, reaching the maximum point, with two hands - arm swing.

From the analysis of the results of the Vertical Separation from the Seat (SVJ.) test, it appears that individual sports practitioners can achieve superior results in all participants compared to the groups represented by sports games practitioners.

The results indicate that athletes recorded the best values of the jump from the spot, as indicated by the group average with a value of 67.133 cm, followed by volleyball players with a value of 58.633 cm and handball players with a 55.400).

When analyzing the results, the athletes achieved 8.5 cm more than the volleyball players and 11.7 cm more than the handball players. Regarding the differences recorded by sports players, volleyball players recorded 3.2 cm more than handball players.

Based on the results obtained from the statistical analysis of the values corresponding to standing vertical jump, we concluded that the potential for vertical jump height from the spot is significantly different for at least one of the groups of athletes involved. Because the ANOVA test does not explicitly tell us which means were different from each other, we used the Independent T-Test to determine this.

As for the statistical indicators of vertical displacement analyzed between the volleyball and handball groups, the results show that the value of the significance index corresponding to the difference between the two means is statistically insignificant.

The statistical indicators of the vertical displacement between the group of athletes and volleyball players indicate that it is statistically significant.

The statistical indicators of the vertical drop from the spot between the group of athletes and handball players indicate that the average difference in vertical drops between the two groups analyzed is statistically significant.

The results of the AVJ test show that the athletes recorded the best release values following the three-step offset.

Based on the results, we concluded that the potential for vertical disengagement following the three-step displacement is significantly different for at least one of the athletes involved, according to the results of the ANOVA test. However, since the ANOVA test does not explicitly tell us which means were different from each other, to determine this, we used the Independent T-Test.

The statistical indicators of the vertical displacement clearance analyzed between the volleyball and handball groups show that the differences are not statistically significant.

The statistical indicators of vertical displacement clearance analyzed between the athlete, and volleyball groups show that the differences are statistically significant.

The statistical indicators of vertical displacement between the group of athletes and the handball players show that the differences are statistically significant.

After analyzing the results obtained, the vertical disengagement capacity on one leg leads us to accept that the athletes obtained higher values compared to the volleyball and handball players for both right and left leg disengagement.

Through our study, we aimed to highlight the most advantageous way an athlete can achieve the vertical release, obtaining superior indices of this type of release.

In order to clarify the differences, athletes underwent a series of tests designed to quantify their ability to perform a vertical jump. First, the vertical jump was done from a standing position than from movement. At the same time, their ability to disengage vertically from each leg was also tested. Comparing the three groups on the vertical jump from a standing position provides clear evidence that the athletes have the highest disengagement.

Comparing the one-legged vertical jump and the two-legged vertical jump indicates that the one-legged vertical release potential is significantly different for the athlete group in both the standing vertical jump and the vertical movement jump.

Thus, our results confirm our study hypothesis that athletes who use the one-legged vertical jump as their primary mode will achieve higher jump height indices than the two-legged jump.

Concerning the groups of athletes who performed the one-legged vertical dismount (athletics - handball), it indicates that there are significant differences between the mean of the two groups analyzed, both for the standing vertical dismount and the two-legged vertical dismount. In this sense, the results confirmed the study's hypothesis that athletes who perform

the vertical dismount on one leg and come from different sports branches can register differences.

Single-legged vertical jump refers to the possibility of athletes jumping from both the left and the right foot. Notably, irrespective of the type of release, all athletes recorded differences between the two lower limbs.

SUMMARY OF CHAPTER VII - PRELIMINARY STUDY II

IMPLEMENTATION STUDY OF THE VERTICAL JUMP ON ONE LEG IN VOLLEYBALL PLAYERS

The objectives of preliminary study II were: to carry out the organization plan and to determine the players of the research group, to learn the vertical jump of one leg from movement, to select and apply the tests necessary to start the preliminary research, to centralize and interpret the data obtained from the tests.

The preliminary study was conducted during the 2019 - 2020 competition season and introduced the vertical single-leg take-off with movement into the athletes' training.

The study's starting point was to achieve the vertical single-leg take-off with movement to obtain superior height indexes in the execution of the attack. To this end, we have stated the following premise:

- players who perform the vertical single-leg take-off with movement will record higher vertical jump indices than those who perform the vertical jump with movement on both legs.

With this study, we aimed to analyze and compare the effectiveness of vertical displacement disengagement on one leg with the same type of disengagement on both legs.

The present study aimed to apply the tests and intervention program designed to lead the athletes to achieve superior vertical jump indices by introducing the vertical single-leg take-off with movement.

Thus, by applying the training aimed at perfecting the one-legged vertical jump attack and developing the combined motor quality, the players will achieve superior results compared to the results obtained from both legs' vertical jump.

The preliminary research was carried out with the help of the athletes of the volleyball team of the "Alexandru Papiu Ilarian" School Sports Club in Dej. The participants involved in the preliminary study were 12 players aged between 15 - 18 years.

The methods used in the preliminary research were: the bibliographical material study method, observation method, conversation method, experimental method, test method and statistical-mathematical method.

The apparatus and materials used in preliminary study II were the following: a thalliometer, a medical device for measuring the waist of individuals, G-Vert device, which demonstrated increased reliability compared to the jumping platform. The device is widely used to demonstrate vertical jump capability based on the measured explosive force.

The motor tests were those established by the Romanian Volleyball Federation and one developed by us to evaluate one leg's vertical jump

In the preliminary research study, the athletes were evaluated on the following tests to record and compare the differences between the two types of jumps.:

Test 1. Vertical jump from movement (one step), jumping from both feet and reaching the maximum point with the arm extended.

Test 2. Vertical jump, from movement (one step), jumping from one leg with reaching the maximum point, with arm extended.

Test 3. Vertical jump, from a movement (three steps), jumping from both feet, reaching the maximum point, with the arm outstretched.

Test 4. Vertical jump, from a movement (three steps), jumping from one leg with reaching the maximum point, with arm extended.

Test 5. Vertical jump, from a standing position, from one leg, reaching the highest point, with two hands, swinging arms, jumping and reaching with both hands as high as possible.

To quantify the high jump, we used the formula used by FRV to calculate the jumping index.

$$IS. = [(T / Î) \times (S2 – Î + S1 – Î)] / 100$$ where:

IS. = jump index;

T = athlete's height;

Î = net height;

S1 = jumping from movement, three-step approach, detachment on both feet, with one-handed, high jump, landing on both feet.;

S2 = high jumping from a standing position with two hands.

The program follows two strands: technical training and physical training. For the acquisition of the ability to jump vertically from one leg, we used preparatory exercises from the school of jumping: jumps with the ball at different heights, jumps with the knee lift to the chest, jumps with the heel lift to the pool, jumps with the trunk extension and pre-technical exercises from the school of jumping: jumping step, alternating arms and jumping step, simultaneous arms, respecting the stages of learning the technique.

For strength development, the power-training method and the circuit method were used in the preliminary research and applied using plyometric exercises. At the stage of information and representation training, the participants of the preliminary study were explained and demonstrated what they had to perform.

The statistical data processing was designed to reveal apparent differences in the evolution of vertical jump values on one leg compared to vertical jump values on both legs.

Following the application of the proposed tests for recording the ball strike point after a one-step and a three-step jump with the Vertec device, the following results are illustrated below.

With the single-leg vertical jump, volleyball players achieved higher maximum point values than when using the vertical jump on both legs. Thus, using the single-leg vertical jump, the results obtained were superior to those obtained using the vertical jump on both legs.

In this sense, the statistical values between the two types of jump show statistically significant differences in favor of the single-leg vertical jump. Therefore, we can say that the vertical single-leg take-off with movement results obtained higher indices than a vertical jump from both legs..

Concerning the results obtained by the participants following the three-step movement, with take-off from one leg and on both legs, the results confirm that higher values of the ball hitting point were recorded by the vertical take-off on one leg compared to the vertical take-off on both legs.

Concerning the results obtained by the participants in the study, materialized in high jump values and measured with the G-Vert device, it highlights the fact that jumping from one leg recorded higher values compared to jumping from both legs..

From the results of the jumping index obtained by each participant, it is clear that the vertical single-leg take-off was superior, classified in the VERY GOOD category, compared to those who dismounted vertically on both legs.

Following the operational approach, the main conclusion is that the study's general hypothesis has been confirmed. Therefore, using the vertical jump on one leg with movement, higher values of the height of the maximum point reached and the detent was scored.

The evidence of the superior results, recorded in the vertical disengagement test, on one leg, following displacement, are outlined as follows:

- Testing the height of the maximum point reached with one hand, performed following the one-legged jump with one-step movement, yields significant differences in the athletes' ability to jump.
- The differences between the two types of jump following the one-step movement indicate that all athletes, who assigned themselves the ability to jump vertically from one leg, could achieve higher values. These findings suggest that vertical jumping from

one leg with movement will produce superior results compared to vertical disengagement from both legs.

- Testing the height of the maximum point reached by comparing the two types of jumps following a three-step approach brings to light statistically significant differences between them.
- The high jump values following the three-step approach, jumping from one leg, are significantly higher compared to the same type of bilateral approach and jump.
- The jump index values, recorded at the vertical jump, from one leg of the three-step approach, recorded ten positions classified as VERY GOOD and two positions classified as GOOD. The quantification of the jumping index obtained when measuring the vertical jump from both legs with approach, and the same number of steps recorded seven positions in the VERY GOOD category and five in the GOOD category. No values were recorded in the SUFFICIENT and INSUFFICIENT categories.

As can be seen, the data obtained from the measurements for each type of approach and jumps were compared in this study. The result of the comparison showed significant differences in favor of the one-legged jump for both the one-step and three-step approach

PART III

COMPARATIVE STUDY ON OPTIMIZING THE TRAINING PROCESS OF JUNIOR PLAYERS BY STREAMLINING THE FIRST LINE ATTACK

SUMMARY OF CHAPTER VIII

OPERATIONAL DESIGN OF THE EXPERIMENTAL STUDY

This research aims to increase the motor capacity and physical condition of volleyball players and increase the efficiency of general and specific physical training.

The experimental study was conducted as follows:

- initial testing took place on 14-15.09.2020;
- the implementation of the training program was run from 21.09.2020 - 10.04.2021;
- the final testing of the physical detention component took place on 30.11.2021;
- the final testing of the technical-tactical component took place on 12,13.04.2021;

The experimental approach involved the following steps:

- Literature review;
- Establishment of the sample and periodization of the research;
- Establishment of strategies and action objectives to improve vertical disengagement capacity;
- Implementation and experimentation of the proposed program;
- Data collection and processing;
- Interpretation and representation of results.

The aim of this research is that, after going through a physical and technical training program, increased efficiency of the first line attack is achieved by using the vertical, one-legged stance from the offset.

The research study aims to develop and implement a training plan with specific and non-specific means to exploit the potential of vertical take-off, designed to facilitate the completion of offensive phases.

The general aim of the experimental study is the evolution of the efficiency parameters in volleyball by aligning the internal performance strategies to the current trends of the game, which are based on surprising the opponent.

The experimental study started from the hypothesis that, by introducing the vertical release of one foot from the offset, athletes can achieve a higher hitting point of the ball, simultaneously increasing the efficiency of attacking actions. At the same time, with this type of jump, higher values will be obtained compared to the performance age group sports in terms of the height of the point reached in the attack.

The overall efficiency coefficient of the first line attack will increase due to the athletes' use of the vertical, one-legged stance following movement.

In this study, a number of 24 athletes of the volleyball teams Club Sportiv Școlar "Alexandru Papiu Ilarian", from Dej municipality, and Club Sportiv Școlar "Viitorul," from Cluj-Napoca municipality, were involved and organized in two groups, the experimental group, and the control group.

The experimental group carried out its activity in the Sports Hall of Dej, while the tests applied to the control group were carried out in the sports hall of the Sports High School of Cluj-Napoca.

All participants were familiarized with the testing procedures performed at least once by all candidates before the start of the study. Both participants in the experimental and control groups were familiar with the test methodology for the physical component assessment of the Vertec device.

As members of sports clubs entered the National Volleyball Championship, they were medically assessed at the county sports medicine office at the beginning of the season. The students were informed before the start of the experimental study about the purpose of the research, the program that's going to be implemented, and the physical tests they would undergo.

The testing of the participants focused on two directions: the height of the maximum point reached following the vertical release from displacement and the height of the detent recorded with the same type of release.

The application of the test to assess the physical component was based on the specific movement of each group participating in the final experiment.

- Those in the experimental group performed the vertical displacement on one leg;
- Those in the control group performed the vertical dismount on both legs.

To quantify the high jump, we used the formula used by the FRV to calculate the jumping

$$\text{index.IS.} = [(T / Î) \times (S2 – Î + S1 – Î)] / 100$$

Where:

IS. - the jump index

T - athlete's height;

Î - net height;

S1 - three-step approach, high jump, one-handed, both feet off the ground;

S2 - jumping from the spot in height with two hands.

We calculated the attack accuracy using the formula proposed by (Terry, 2019; DataVolley, 2007), which takes into account the attack efficiency coefficient. The attack

efficiency coefficient equals the difference between successful and unsuccessful attacks divided by the total actions executed.

$$K = (X-Y)/(X+Y)$$

Where:

K - coefficient of efficiency;

X - actions won;

Y – actions lost.

According to (the Academic Development Centre, West University of Timisoara, 2019), effect size refers to the magnitude of a phenomenon under consideration. Effect size tells us how significant an impact the strategy or intervention has on participants' learning success.

The calculation formula proposed by the Academic Development Centre mentioned above is a simple one and is given by the ratio of the difference between the means of the two groups and the mean of the standard deviations of the two groups, as follows.:

$$ME = \frac{Mg1 - Mg2}{(Dstd.G1 + Dstd.G2)/2}$$

Where:

ME – effect size;

Mg1 – mean of the first group;

Mg2 – mean of the second group;

Dstd.G1 – standard deviation of the first group;

Dstd.G2 – the standard deviation of the second group.

The methods used in the experimental study are the methods specified in the preliminary research studies I and II. The following methods were used for this study: conversation method, observation method; experiment method; test method, and statistical method.

Following the results of the preliminary studies conducted previously, it was necessary to conduct further research on the role of the one-legged release in optimizing the offensive actions of volleyball players. For this purpose, we developed a training plan to be used for validation in the experimental group. It was applied in two directions: a technical-tactical one, aimed at strengthening the vertical take-off on one leg, with a duration of 29 weeks, distributed according to the appendices, and a direction focused on the physical development of the players.

Optimizing the physical preparation of volleyball players is a vital aspect, which requires a great deal of attention on the part of those involved and beyond.

Considering the aspects discussed in the previous chapters, we can configure the main directions necessary to improve the physical and technical preparation of the players involved in the experimental study.

In order to develop strength, we developed a macrocycle that ran for ten weeks using plyometric exercises and TRX. Each macrocycle comprised four weekly workouts, each lasting 90 minutes, focused primarily on developing combined motor quality and high jump. Maximum heart rate was calculated according to the formula HRmax = 202 – (0,55 x age), because health restrictions did not allow the us of approved medical devices.

The statistical processing of the data aimed to show convincing results on the evolution of the vertical single-leg take-off with movement compared to the vertical jump of both legs. Thus, the values obtained by the experimental group following the proposed tests to determine the height of the hitting point, compared with the values of the control group and the finalists of the European Confederations Volleyball Championship Under 17 Men (CEV U17M) were followed.

Quantification of the physical component - the high jump was compared only between the experimental and control groups. At the same time, the results were compared between groups, and the effect size b was determined.

The results achieved by the experimental group in the initial and final tests of vertical jump ability following the three-step approach from one leg indicate that the difference between the two categories of values is highly statistically significant.

Regarding the results obtained by the members of the experimental group and the results of the athletes of the control group on the lower body strength, we conclude that the difference in means is statistically relevant. Specifically, by using the vertical jump on one leg of with approach, the experimental group members obtained statistically significant values compared to the use of the same type of release on both legs performed by the control group.

The height of the maximum point reached by the experimental group and the control group members in the final tests reveals that the experimental group members achieved higher values in the final test than the control group members.

Statistical analysis of the two groups of values says that vertical jump off one leg with the approach will result in higher indices of maximum height achieved compared to vertical jump with approach on both legs.

The result of the effect size coefficient indicates a substantial effect on the experimental group compared to the control group, from which we can conclude that the effect is statistically and practically significant.

As for the height of the ball hitting point, this was calculated by adding the height of the players with their arm outstretched and the height of the jump. Currently, no device records the height of the ball hitting point in real-time.

The height of the attack obtained by the players of the Polish team and by the participants of the experimental group in the final measurements, made by taking off from one foot with approach, indicate that the players of the experimental group have values close to those of the Polish team.

The statistical processing of the values of the hitting point height for the Polish team players and the experimental group members obtained in the final test indicates that the difference between the two means is not statistically significant. Therefore, by vertically jumping off one foot, no higher values of the attack point height will be obtained compared to the values recorded by the players of Poland.

Concerning the statistical values of the height of the hitting point of the ball for the players of the French team and the experimental group members obtained in the final test, the results indicate that the differences between the two means are not statistically significant.

Analyzing the results of the progressive evolution of the accuracy values of the attack, we can state that the results of the successful executions according to the zone in which the attack was carried out, leading us to admit the following. The experimental group members, occupants of the outside hitter, attacked with superior indices of accuracy and ease from one leg from zone 4 to zone 5.

In the same study, the results of the successful executions according to the zone in which the attack was performed leads us to the finding that the members of the experimental group and occupants of the middle blocker position executed the one-legged attack from zone 3 to zone 5 with superior accuracy and ease. Therefore, we can conclude that by performing the movement behind the setter, the chances of success are higher than if the movement were performed in front of the setter.

Investigating the successful executions according to the zone in which the attack was carried out leads us to admit that the members of the experimental group, occupants of the universal shooting position, carried out the single-leg detachment attack with superior accuracy rates, moving from zone 2 to zone 5.

This study aimed to promote new ideas in terms of training methodology, which would help identify and eliminate training deficiencies of junior volleyball teams. Interdisciplinary research has led to significant sporting performances in this field.

The techniques of driving through exercises specially designed to improve motor skills, along with those that focused on the technical-tactical component, helped to increase the accuracy of the execution of the attack from the front line.

In our case, the results obtained in the two groups involved in the experimental research indicate that the values of the target parameters were higher in the experimental group than in the control group. These results were acquired using the AVJ test, which mainly aims to obtain a maximum detachment or reach a maximum point. In the case of the performance capacity materialized by their ability to disengage vertically from one leg, significant results were found for both the height of the maximum point reached and the height of the detent exerted following disengagement.

The height of the vertical separation on both legs shown in the research papers, according to authors Bubanj, Stanković, Bubanj, Dimić, Bednarik, and Kolar (2010), was lower compared to the vertical separation on one leg. Therefore, our research can join the other studies in the literature by the aspects revealed regarding the vertical jump on one leg as superior to vertical jump on both legs.

At the same time, Mikolajec, Waskiewicz, Maszczyk, Bacik, Kurek, and Zając (2012; 2017) found that vertical disengagement following displacement requires shortening-lengthening cycles of the muscle. Such neuromuscular exercises are efficient, helping to develop strength due to concentric contractions before jumping.

The results recorded in the experimental study using plyometric exercises applied to the experimental group in the final tests resulted in significant differences in lower body detent compared to the initial tests.

Hewit (2015) argues that dynamic movements in sporting activity do not always have to be performed on both feet simultaneously; athletes often have to perform jumps, landings, changes of direction, accelerations, and sudden stops, using the lower limbs alternately. As such, strength, endurance, and the ability to perform specific technical elements may differ between the right and left lower leg. We also substantiated the author's assertion in Chapter VI - Preliminary Study I, which was intended, among other things, to highlight the differences in strength between the right and left legs. The measurements of the lower body strength, individually for each leg, indicated that all athletes recorded higher values of the right leg compared to the left.

Author Saunders (1980) conducted a study in which he recorded three basketball players and three volleyball players who were asked to perform ten executions of the one-legged and two-legged take-off movement, concluding that during the one-legged take-off, the participants

benefited from a superior flight phase due to the free foot swing. The finding supports these claims that the take-off from one leg, due to free limb swing, achieved 0.35m more than the take-off with both legs in contact with the surface.

Our results from preliminary study I, which compared the two types of release in three categories of athletes, indicate the same. Individual sports practitioners (athletes) compared to sports game practitioners (volleyball players) could achieve significant values of both standing and offset jumps using the one-legged vertical jump..

Tai, Wang, and Peng (2018) point out that disengaging from one and both legs following movement is often used in training, but sometimes also in competitions, and is considered an essential skill for volleyball players with involvement in both offensive and defensive phases.

Another way in which we tried to measure the efficiency of the one-legged striding attack was to calculate the jumping index, which, according to Stupar, Monea, and Șanta (2021), is an essential indicator of athlete performance.

Thus, we can mention that more participants in the experimental group obtained numerical superiority (11 positions in the VERY GOOD category) compared to the positions occupied by the control group (9 positions in the VERY GOOD category). As a result, we can note that by using vertical jump from one leg with approach, volleyballers will obtain more values close to the maximum threshold compared to vertical disengagement from both legs.

Analyzing the opinions of national club coaches, the supreme quality of the one-legged attack is that players can benefit from a superior jump and thus have the possibility to overcome the opponent's block. The results presented in the preliminary and experimental study also support the above.

With all these possibilities and peculiarities of the one-legged attack, it is not an action found in the offensive tactics of modern men's volleyball, as reported to us by the coaches of the national teams. They say that studying the most appropriate timing for the one-legged, first-line break attack is not a modern trend that can improve the athletic performance of volleyball players. The benefits of implementing the one-legged attack depend on the positions occupied on the court, the players' capabilities to execute this type of attack, and the requirements of modern men's volleyball.

The execution of the one-legged jump attack depends on the zone in which the ball is delivered. It is more efficient if it is executed from zone 3 toward zone 2, as shown in the experimental study. According to the opinion of the coaches and the characteristics of modern volleyball, zone 2 is the primary zone for the opposite hitter, who acts on the ball from the

second line. Therefore, the opposite hitter should be removed from the game to give the middle blocker a chance to attack..

As a result of the scientific approach carried out, using concrete arguments reinforced by calculations and statistical-mathematical analyses, the research hypothesis is confirmed, i.e., that, by taking off vertically of one foot, players will be able to obtain a higher hitting point of the ball simultaneously with an increase in the efficiency of attacking actions.

The statistical-mathematical processing coupled with the graphical representation that reflects as eloquently as possible the upward dynamics of the recorded results corresponding to the sample of the experimental group entitles us to formulate the following conclusions, which reinforce the confirmation of the general hypothesis of the present research study:

- The superior results obtained by the sample of the experimental group in the final test compared to the initial test and the control group's results in relation to the detente of the lower train reject the null hypothesis.
- The superior results obtained by the experimental group in the final test compared to the initial test and the control group's results in relation to the height of the maximum point reached following the vertical displacement separation reject the null hypothesis.
- Concerning the height of the hitting point of the ball, the results obtained by the experimental group at the final test compared to the results of the sports performance model corresponding to the age category, the null hypothesis is accepted.
- The superior results obtained by the sample of subjects in the final test compared to the initial test and the control group test concerning the increase in the quality of the attack accuracy in line I lead to the acceptance of the specific hypothesis.

From the study of the final results obtained, we can conclude that, in our opinion, the one-legged first line attack led to superior results in terms of the height of the maximum point reached after the displacement and an increase in the efficiency of the attacking actions.

The final aim of this thesis was to identify some aspects of service use in junior men's volleyball. The secondary aim of the present research was to determine the effect of a training plan, directed by technological means, on the sports performance of the subjects involved.

The present study has succeeded in creating a possible benchmark for volleyball players' physical and technical training to optimize their offensive actions. The proposed and applied work program, with a rich background in plyometric exercises and TRX exercises, greatly impacted the athletes' training, which led to superior results recorded in the final test compared to the initial test. This achieves the proposed goal that the potential of the participants' vertical jump will be harnessed by implementing a physical training plan.

The statistical-mathematical processing, accompanied by graphical representations, highlights as eloquently as possible the ascendancy of the results recorded by the sample of the experimental group compared to the control group. Thus, we are justified in admitting the hypothesis that by moving one foot vertically out of motion, a higher hitting point of the ball will be obtained, simultaneously with an increase in the efficiency of the attacking actions.

In this regard, the results obtained in the two groups involved in the experimental research indicate that the values of the parameters monitored were higher in the experimental group than in the control group. In the performance capacity, materialized by their ability to jump vertically from one leg with approach, superior results were found both in the height of the maximum point reached and in the height of the detent exerted following detachment.

The vertical single-leg take-off with movement is an essential component of volleyball performance. We can say that it is a crucial element in preventing effective defensive tactics from the opponent. The manner of the one-legged attack and its ability to affect the opponent's game is not only based on the execution's speed but also influenced by the players' jumping skills.

The successful execution of the one-legged attack is a complex skill, conditioned by the physical, technical, and tactical components and the other skills specific to the volleyball game. However, correctly using this technical skill is paramount for the outcome of a high-level match to be differentiated.

To disseminate of the results, papers have been published highlighting specific aspects of the research process.

Stupar R.C., Monea G., Șanta C., Grosu E.F. , Hanțiu I. (2018) Comparative Study Between the Vertical Detachment of One Foot and the Vertical Detachment of Both Feet with One Step and Two Steps Take-Off Approach. *4th International Conference of the Universitaria Consortium* - The Impact of Sport and Physical Education Science on Today's Society 23-24 November, 2018 – Iași. p.341;
https://www.sport.uaic.ro/tmp/files/2018/11/PROGRAM-UNIVERSITARIA.pdf

Stupar R.C., Monea Gh., Monea D., Șanta C. (2019) Comparative study on implementation of one leg take of in the volleyball game to the center players. *The 5th International Conference of the Universitaria Consortium. Education for Health and Performance*.11-12. October, 2019- Cluj-Napoca. p.399;
https://efop522.diaktanacsado.hu/en/proceeding-of-icu-2019-book

Stupar R.C., Monea G., Șanta C., Somîtcă A.I. (2020) Comparative study on the use of a portable alternative method for measuring high jump in men's volleyball game. *Studia Universitatis Babes-Bolyai, Educatio Artis Gymnasticae* . Vol. 65 Issue 3, p115-122. 8p; http://www.studia.ubbcluj.ro/download/pdf/educatio/2020_3/09.pdf

Stupar, R.C., Monea, Gh., Șanta, C. (2021). U17 Romanian Volleyball Player's Approach Height Analysis, Related To The Jump Index As A Performance Indicator, *7th International Conference of the Universitaria Consortium in Physical Education, Sports and Physical Therapy,* pag. 112 https://www.kspu.edu/FileDownload.ashx/ICU%202021%20CONFERENCE%20PROGRAM.pdf?id=0633e896-c006-407d-9ce8-f2167df359af

In the present study, we tried to implement a training model in a men's volleyball team, junior category, aiming the increase the attack efficiency index and the performance index, which materialized in the athletes' ability to obtain higher jump values in the lower limbs using one-legged take-off depending on the specific position occupied on the court.

At the national level, we have no information on any other work addressing the implementation of the one-legged spike attack in men's volleyball and especially in junior volleyball. Also another original element is the fact that, for the first time, we quantify the vertical, one-legged take-off ability from the offset in junior men's volleyball players.

At the same time, it is the first to record the height of the point of attack in real-time in volleyball players, thus calculating the efficiency of implementing this procedure. At the same time, the study is a starting point in the attempt to implement this procedure to opposite hitters, who also showed an efficiency close to the values of the player in zone 3.

The results obtained from the research confirm and reinforce the idea of introducing in the physical and technical-tactical training of junior volleyball players a training plan designed to promote the construction of an element specific to the volleyball demands.

Following the research undertaken and the increasingly demanding requirements of increasing the competitiveness of individual game actions in volleyball, we formulate some recommendations that, in our opinion, can increase the efficiency of the technical-tactical actions of the first-line attack.

The first recommendation is to integrate a one-legged attack into the early training of volleyball players. As it is the simplest form of vertical release, children could master this technique in a short period.

Next, we recommend using the one-legged attack when the set and delivery of the ball from serve or attack are excellent. Only with such a pick-up can the opponent be surprised, as he will not be able to guess the next area where the ball will be passed.

Coaches of junior teams should consider using functional training programs, specifically TRX and plyometric exercises, to improve player fitness.

In order to obtain additional information about athletes' ability to perform vertical dismount, coaches should use wearable devices to provide this information in real-time. With this method of recording, coaches would not only be limited to the results of regular testing, quantified by tests and control samples.

One of the limitations of our experimental study is the small sample of subjects. This limitation arises due to the small number of volleyball team members, approximately 14 members. This limitation comes from the fact that there are not several junior men's volleyball teams operating in the same locality. Therefore, cumulating the participants of two teams from different localities to have an adequate sample for the application of the study would have led to deficiencies and training errors. Furthermore, observing the behavior and development of two teams from different localities would have been impractical.

Another limitation of the research was the emergence of the SARS-Cov-2 virus, which caused the emergence of COVID 19. Because of this, a series of restrictive measures were implemented at the national level. These included a ban on access to sports matches, which prevented us from tracking and recording the progress of the players in order to apply vertical, single-legged detachment.

Also, due to the emergence of the pandemic, the study was made more difficult because of the rules of social distancing, time limitation, and access to confined spaces.

Another impediment caused by the SARS-Cov-2 virus outbreak was the prohibition of using devices other than personal ones, which made it difficult for us to record heart rate accurately.

REFERENCES

Abd al-Rahman, Z. (2019). Efectele exercițiilor pliometrice cu metodă de antrenament repetitiv asupra performanței saltului vertical și a abilităților de fotbal: un studiu experimental realizat pe jucători juniori, echipa U-17. *Khemis MC Soccer. Elibdaa el-Riadhi,* Vol. 10, nr. 2, pp.121-139, https://search.emarefa.net/detail/BIM-995113;

Alanen, A.M., Räisänen, A., Benson, L., și Pasanen, K. (2021). The use of inertial measurement units for analyzing change of direction movement in sports: A scoping review. International *Journal of Sports Science & Coaching*. https://doi.org/10.1177/17479541211003064;

Amonette, W. E., Brown, L. E., De Witt, J. K., Dupler, T. L., Tran, T. T., Tufano, J. J., și Spiering, B. A. (2012). Peak vertical jump power estimations in youths and young adults. *Journal of strength and conditioning research*, *26*(7), 1749–1755. https://doi.org/10.1519/JSC.0b013e3182576f1e;

Arazi, H., Malakootinia, F. și Izadi, M. (2018). Effects of eight weeks of TRX versus traditional resistance training on physical fitness factors and extremities perimeter of non-athlete underweight females. *Physical Activity Review*, vol. 6, 73-80. 10.16926/par.2018.06.10;

Baker, J. (2003). Early specialization in youth sport: A requirement for adult expertise? *High Ability Studies*, 14(1), 85-94;

Baker, J., Cobley, S. și Fraser-Thomas, J. (2009). What do we know about early sport specialization? Not much! *High Ability Studies*, 20(1), 77-89;

Belyaev, A.V. (2011). Volleyball: theory and methodology of training. TVT «Division».

Bergeles, N., Barzouka, K., și Nikolaidou, M. (2009). Performance of male and female setters and attackers on Olympic-level volleyball teams. *International Journal of Performance Analysis of Sport*, 9, 141–148,

Boichuk, R., Iermakov, S., Nosko, M., Kovtsun, V. și Nosko, Y. (2017). Influence of motor coordination indicators on efficiency of game activity of volleyball players at the stage of specialized basic training, *Journal of Physical Education and Sport* ® (JPES), 17(4), Art 301, pp. 2632 - 2637, ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES;

Bokan, M. (2009). Motor Abilities of Volleyball Players and Tests for Their Estimation, *Physical Culture, Belgrade*, 63, p. 126-134, pict. 15, ref. 28;

Bompa, T.O. și Gregory Haff G.G. (2009). Periodization : theory and methodology of training, *Human Kinetics*;

Borges, T. O., Moreira, A., Bacchi, R., Finotti, R. L., Ramos, M., Lopes, C. R., și Aoki, M. S. (2017). Validation of the VERT wearable jump monitor device in elite youth volleyball players. *Biology of sport*, 34(3), 239–242. https://doi.org/10.5114/biolsport.2017.66000;

Borreani, S., Calatayud, J., Colado, J.C., Moya-Nájera, D., Triplett, N.T. și Martin, F. (2015). Muscle activation during push-ups performed under stable and unstable conditions. *J. Exerc. Sci. Fit*. 13, 94–98;

Bubanj, S., Stanković, R., Bubanj, R., Dimić, A., Bednarik, J. și Kolar, E. (2010). One leg vs two-legs vertical jumping performance. *Facta universitatis. Series physical education and sport, 8,* 89-95;

Caldwell, S.C., Trench, E.M., Hoover J.L. și Bucheger N.M. (2006). Differences between jumping and non-jumping leg in Division III collegiate track and field jumpers University of Wisconsin-Eau Claire. *J. Undergrad. Kin. Res; 1(2): 1-7;*

Charlton, P., Kenneally-Dabrowski, C., Sheppard, J. și Spratford W. (2016). A simple method for quantifying jump loads in volleyball athletes. *Journal of Science and Medicine in Sport.* 20. 10.1016/j.jsams.2016.07.007;

Charlton, P. C., Kenneally-Dabrowski, C., Sheppard, J. și Spratford, W. (2017). A simple method for quantifying jump loads in volleyball athletes. *Journal of science and medicine in sport*. 20(3), 241–245. https://doi.org/10.1016/j.jsams.2016.07.007;

Cissik, J., Hedrick, A. și Barnes, M. (2008). Challenges Applying the Research on Periodization. *Strength & Conditioning Journal*. 30. 45-51. 10.1519/SSC.0b013e3181637f83;

Ciulea, L. și Burcă, I. (2015). Physical training, an important factor in the training of junior female volleyball players. *University of Medicine and Pharmacy*. Târgu Mureș, *Palestrica of the third millennium – Civilization and Sport Vol*. 16, no. 3, 223–227;

Cojocaru, A. și Cojocaru, M. (2012). *Volei Curs în tehnologie IFR*, Ed. Fundatia România de Mâine, Bucuresti;

Cojocaru, A.M. și Cojocaru, M. (2015). Optimisation of speed in volleyball game through specific means,Spiru Haret University Bucharest, Romania ,*Journal of Sport and Kinetic Movemen.* Vol. II, No. 26/2015;

Cojocaru, A.M. și Cojocaru, M. (2019). Develop Vertical Jump to Junior Volleyball Players by Plyometric Special Means. In C. Ignatescu (ed.), *12th LUMEN International Scientific Conference Rethinking Social Action. Core Values in Practice*. 15-17 May. Iasi –

Romania (pp. 49-56). Iasi, Romania: LUMEN Proceedings. https://doi.org/10.18662/lumproc.152;

Cojocaru A., Lăzărescu D. și Ștefănescu A. (2013). *Ghid orientativ al antrenorului de volei*, București;

Costa, G., Caetano, R., Ferreira, N.N., Junqueira, G.D., Afonso, J., Costa, R., și Mesquita, I. (2011). Determinants of attack tactics in Youth male elite volleyball. *International Journal of Performance Analysis in Sport*. 11, 104 – 96;

Coutinho, P., Mesquita, I., Fonseca, A. și Côté J. (2015). Expertise development in volleyball: The role of early sport activities and players' age and height. *Kinesiology*. 47. 215-225;

Coutinho, P., Mesquita, I., Fonseca, A.M. și De Martin-Silva, L. (2014). Patterns of sport participation in Portuguese volleyball players according to expertise level and gender. *International Journal of Sport Science & Coaching*. 9(4), 579-592;

Dapp, L., Gashaj, V. și Roebers, C. (2021). Physical Activity and Motor Skills in Children: A Differentiated Approach. *Psychology of Sport and Exercise*. 54. 101916. 10.1016 ISSN 1469-0292,https://doi.org/ 10.1016/ j.psychsport;

Dolati, M., Ghazalian, F. și Abednatanzi, H. (2017). The Effect of a Period of TRX Training on Lipid Profile and Body Composition in Overweight Women. *International Journal of Sports Science,* 151-158. 10.5923/j.sports.20170703.09, doi:10.5923/j.sports.20170703.09;

Duncan, M.J., Woodfield, L. și al-Nakeeb, Y. (2006). Anthropometric and physiological characteristics of junior elite volleyball players. *Br J Sports Med*.;40(7):649-51; discussion 651. doi: 10.1136/bjsm.2005.021998. PMID: 16799112; PMCID: PMC2564319;

Epuran, M. și Marolicaru, M. (2006). *Metodologia cercetării activităților corporale*, Ed. Risoprint, Cluj-Napoca;

Fraser-Thomas, J. și Côté, J. (2009). Understanding adolescents' positive and negative developmental experiences in sport. *The Sport Psychologist.* 23, 3-23;

Gamaliy, V.V. și Shlonska, O.L. (2016). Technical and tactical training of qualified athletes in team kinds of sport with a limited playing space (on a material of volleyball). *Science in the Olympic sport*. (1), 51 – 58;

Govind, B.T., Milind, V.B. și Anil, D. S. (2013). A Profile of Fitness and Performance of Volleyball Players. *Journal of Krishna Institute of Medical Sciences University*. Vol. 2. P. 2;

Grainger, M., Weisberg, A., Stergiou, P. și Katz, L. (2020). Comparison of two methods in the estimation of vertical jump height. *Journal of Human Sport and Exercise.* 15(3), 623-632. doi:https://doi.org/10.14198/jhse.2020.153.12;

Hanțiu, I., (2003). *Teoria și metodica Educație Fizice și Sportului*. *Note de curs*. Oradea;

Harman, E., Rosenstein, M., Frykman, P., Rosenstein, R., și Kraemer, W. (1991). Estimation of Human Power Output from Vertical Jump. *Journal of Strength and Conditioning Research, 5,* 116–120;

Hartmann, H., Wirth, K., Keiner, M., Mickel, C., Sander, A. și Szilvas, E. (2015). Short-term Periodization Models: Effects on Strength and Speed-strength. *Performance. Sports medicine*. (Auckland, N.Z.), 45(10), 1373–1386. https://doi.org/10.1007/s40279-015-0355-2;

Hileno, R., Arasanz, M., & García-de-Alcaraz, A. (2020). The Sequencing of Game Complexes in Women's Volleyball. *Frontiers in psychology*. 11, 739. https://doi.org/10.3389/fpsyg.2020.00739;

Hileno, R. și Busca, B. (2012). Observational tool for analyzing attack coverage in volleyball. *Revista Internacional de Medicina Y Ciencias de La Actividad Fisica Y Del Deporte.* 12(47), 557-570;

Hutchison, A.T și Stone, A.L. (2009). Validity of an alternative system for measuring vertical jump height. *JEPonline*; 12(3):6-11;

Ide, B., Silvatti, A., Marocolo, M., Santos, C., Da Silva, B., Oranchuk, D. și Mota, G. (2021). Is There Any Non-functional Training? A Conceptual Review. *Frontiers in Sports and Active Living*, Vol. 3. DOI=10.3389/fspor.2021.803366;

Ioan, A. (2017). Frecvența cardiacă maximă și zonele de antrenament, *Buletinul Universității Naționale de Apărare „Carol I“,* Martie 2017;

Imas, E.V., Borisova, O.V. (2016). *Professional tennis: problems and development prospects.* Olympic literature;

Irek, M. F., Lilija, M. A., Nurmaganbet, E. T. (2017). Study of special endurance of young volleyball players of different age groups and its impact on the effectiveness of the performance of certain game actions, Journal of Physical Education and Sport ® (JPES), 17(4), Art 285, pp. 2526 - 2530., ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES, DOI:10.7752/jpes.2017.04285.

Issurin, V. (2014). Periodization training from ancient precursors to structured block models. *Kinesiology*. 46. 3-9;

Jafari, M., Zolaktaf, V., și Marandi, S. M. (2013). Determination of the best pre-jump height for improvement of two-legged vertical jump. *International journal of preventive medicine*. 4(Suppl 1), S104–S109;

Janot, J., Heltne, T., Welles, C., Riedl, J., Anderson, H., Howard, A., și Myhre, S. L. (2013). Effects of trx versus traditional resistance training programs on measures of muscular performance in adults. *Journal of Fitness Research*. 2(2), 23–38;

Kariyama, Y., Mori, K. și Ogata, M. (2011). The differences between double and single leg takeoff on joint kinetics during rebound-type jump. *Porto International Society of Biomechanics in Sports*. ISBS - Conference Proceedings Archive; 279-282.;

Koekoek, J., van der Mars, H., van der Kamp, J., Walinga, W., și van Hilvoorde, I. (2018). Aligning digital video technology with game pedagogy in physical education. *Journal of Physical Education, Recreation & Dance*, 89(1), 12–22. doi:10.1080/07303084.2017.1390504;

Klavora, P. (2000). Vertical-jump Tests: A Critical Review. *Strength & Conditioning Journal*. 22. 70. 10.1519/1533-4295(2000)022<0070:VJTACR>2.0.CO;2;

Kuzkin, V., Lokshin, A. și Roberts-Thomson, C. (2014). Jump Detection Using Fuzzy Logic. *IEEE Symposium on Computational Intelligence for Engineering Solutions (CIES)*, 2014, pp. 125-131, doi: 10.1109/CIES.2014.7011841;

Laporta, L., Nikolaidis, P., Thomas, L., și Afonso, J. (2015). Attack Coverage in High-Level Men's Volleyball: Organization on the Edge of Chaos?. *Journal of human kinetics*, 47, 249–257. https://doi.org/10.1515/hukin-2015-0080;

Lima, R. F., Palao, J. M., și Clemente, F. M. (2019). Jump Performance During Official Matches in Elite Volleyball Players: A Pilot Study. *Journal of human kinetics*. 67, 259–269. https://doi.org/10.2478/hukin-2018-0080;

Lloyd, R.S., Olive,r J.L., Faigenbaum, A.D., Howard, R., Croix, M., Williams, C.A. și Myer, G. (2014a). Long-term athletic development – Part 1: A pathway for all youth. *Journal of Strength & Conditioning Research*. 29(5),1439-1450;

Lloyd, R.S., Oliver, J.L., Faigenbaum, A.D., Howard, R., Croix, M., Williams, C.A. și Myer, G. (2014b). Long-term athletic development – Part 2: Barriers to success and potential solutions. *Journal of Strength & Conditioning Research*. 29(5), 1451-1464;

Lopes, J., da Silva, K. și Reeberg, S. L. (2021). Periodization of volleyball training: characterization of training loads distribution in different macrocycles of Brazilian national u-19 male players. *Human Movement*. 22(1), 33-41. https://doi.org/10.5114/hm.2021.98462;

Lorenz, D. S., Reiman, M. P. și Walker, J. C. (2010). Periodization: Current Review and Suggested Implementation for Athletic Rehabilitation. *Sports Health*. 2(6), 509–518. https://doi.org/10.1177/1941738110375910;

Loureiro, M., Hurst, M., Valongo, B., Nikolaidis, P., Laporta, L., și Afonso, J. (2017). A comprehensive mapping of high-level men's volleyball gameplay through social network analysis: Analysing serve, side-out, side-out transition and transition. *Montenegrin Journal of Sports Science and Medicine*. 6(2), 35-41. doi: 10.26773/mjssm.2017.09.005;

Lică, L. și Mihăilescu, L. (2017). Posibilități de evaluarea și dirijare științifică a pregătirii fizice la volei, Teză de doctorat;

Lungu, S. (2015). *Regulamentul jocului de volei, Caracteristicile jocului, filozofia regulilor de joc și a arbitrajului*, Aprobat de FIVB 2012;

Lyakh, V., Mikolajec, K., Bujas, P., Litkowycz, R. (2014). Review of Platonov's "Sports Training Periodization. General Theory and its Practical Application" – Kiev: Olympic Literature, 2013. *Journal of human kinetics*. 44. 259-63. 10.2478/hukin-2014-0131;

Lyakh, V., Mikołajec, K., Bujas, P., Witkowski, Z., Zając, T., Litkowycz, R., și Banyś, D. (2016). Periodization in Team Sport Games - A Review of Current Knowledge and Modern Trends in Competitive Sports. *Journal of Human Kinetics*. 54, 173–180. https://doi.org/10.1515/hukin-2016-0053;

MacDonald, K., Bahr, R., Baltich, J., Whittaker, J. L., și Meeuwisse, W. H. (2017). Validation of an inertial measurement unit for the measurement of jump count and height. *Physical therapy in sport : official journal of the Association of Chartered Physiotherapists in Sports Medicine, 25*, 15–19. https://doi.org/10.1016/j.ptsp.2016.12.001;

Madden S. (2012). Performance conditioning for volleyball — Vol. 5, No. 7 pag. 5.

Mahmutović, I., Radjo, I., Talović, M., Lakota, R., Alić, Ha. și Jelešković, E. (2016). Level of Transformation of Motor Skills in Female Volleyball Players Influenced by Training Operators. *Sport Mont Journal*. 14. 39-43;

Malliaropoulos, N., Panagiotis, T., Jurdan, M., Vasilis, K., Debasish, P., Peter, M. și Tsapralis, K. (2015). Muscle and intensity based hamstring exercise classification in elite female track and field athletes: Implications for exercise selection during rehabilitation. *Open Access J. Sport. Med*. 209;

Marques, Jr. N. (2018). Specific periodization for the volleyball: a training organization. *MOJ Sports Medicine*. 2. 10.15406/mojsm.2018.02.00056;

Marques, Jr. N. (2020). Specific periodization for the volleyball: the importance of the residual training effects. *MOJ Sports Medicine*, Volume 4 Issue 1 - 2020, 10.15406/mojsm.2020.04.00086;

Marques, Jr. N. (2020). Specificity principle applied in the volleyball. *MOJ Sports Medicine*, Volume 4 Issue 1 – 2020, 10.15406/mojsm.2020.04.00087;

Marque, M.C, van den Tillaar, R., Gabbett, T.J., Reis, V.M. și González-Badillo, J.J. (2009). Physical Fitness Qualities of Professional Volleyball Players: Determination of Positional Differences. *Journal of Strength and Conditioning Research*, 23(4), 1106-1111. https://doi.org/10.1519/JSC.0b013e31819b78c4;

Marquina, M., Lorenzo-Calvo, J., Rivilla-García, J., García-Aliaga, A., și Refoyo Román, I. (2021). Effects on strength, power and speed execution using exercise balls, Semi-Sphere Balance Balls and Suspension Training Devices. A Systematic Review. *International journal of environmental research and public health*, 18(3), 1026. https://doi.org/10.3390/ijerph18031026;

Mazon, J., Gastaldi, A., Sacco, T., Cozza, I., Veloso, D. S. și Souza, H. (2011). Effects of training periodization on cardiac autonomic modulation and endogenous stress markers in volleyball players. *Scandinavian journal of medicine & science in sports*. 23. 10.1111/j.1600-0838.2011.01357.x;

Mazzei, L., Meira, T., Böhme, S., Bosscher, V., Bastos, C., Böhme, M. și Bastos, F. (2015). High performance sport in Brazil Structure and policies comparison with the international context. *Gestion y Politica Publica*. temático. 83;

McGarry, T., Anderson, D.I., Wallace, S., Hughes, M., și Franks, I.M. (2002). Sport competition as a dynamical selforganizing system. *J. Sports Sci*. 20 pp. 771–781. doi:10.1080/026404102320675620;

Mihalik, J. P., Libby, J. J., Battaglini, C. L., și McMurray, R. G. (2008). Comparing short-term complex and compound training programs on vertical jump height and power output. *Journal of strength and conditioning research*, *22*(1), 47–53. https://doi.org/10.1519/JSC.0b013e31815eee9e;

Mikołajec, K., Maszczyk, A., Chalimoniuk, M., Langfort, J., Gołaś A. și Zajc, A. (2017) The influence of strength exercises of the lower limbs on postural stability: A possible role of the autonomic nervous system. *Isokinet Exerc Sci*.; 25(2): 79-89;

Mikolajec, K., Waskiewicz, Z., Maszczyk, A., Bacik, B., Kurek, P. și Zając, A. (2012). Effects of stretching and strength exercises on speed and power abilities in male basketball players. *Isokinet Exerc Sci*.; 20(1): 61-69;

Milić, M., Grgantov, Z., Chamari, K., Ardigò, L., Bianco, A. și Padulo, J. (2017). Anthropometric and physical characteristics allow differentiation of young female volleyball players according to playing position and level of expertise. *Biology of Sport*, 34(1), 19-26. https://doi.org/10.5114/biolsport. 2017.63382;

Milo, N., Grosu, E. și Milo, M. (2017). Vertical Jump Enhancement with Respect to Volleyball Vertical Jump. *Studia Universitatis Babeş-Bolyai Educatio Artis Gymnasticae*. 62. 87-102. 10.24193/subbeag.62(4).36;

Damian, M., Popescu, R., Oltean, A., Traicu C. și Giurgiu L. (2014). PLYOMETRIC EXERCISES TO IMPROVE EXPLOSIVE POWER IN ARTISTIC GYMNASTICS. *Science, Movement and Health*, Vol. XIV, ISSUE 2 Supplement;

Modrick, S. (2019). Changes in Vertical Jump Components Utilizing the Myvert Device in Female Collegiate D-1 Volleyball Players. *Electronic Theses and Dissertations*, 3170. https://openprairie.sdstate.edu/etd/3170;

Moșneag, H. și Muresan, A. (2004). *Volei Specializare, Note de curs*, Cluj-Napoca;

Mroczek, D., Superlak, E., Kawczyński, A., și Chmura, J. (2017). Relationships between motor abilities and volleyball performance skills in 15-year-old talent-identified volleyball players. *Baltic Journal of Health and Physical Activity, 9*;

Mujika, I., Halson, S., Burke, L. M., Balagué, G. și Farrow, D. (2018). An Integrated, Multifactorial Approach to Periodization for Optimal Performance in Individual and Team Sports. *International journal of sports physiology and performance*, 13(5), 538–561. https://doi.org/10.1123/ijspp.2018-0093;

Muratori, L. M., Lamberg, E. M., Quinn, L., și Duff, S. V. (2013). Applying principles of motor learning and control to upper extremity rehabilitation. *Journal of hand therapy : official journal of the American Society of Hand Therapists*, 26(2), 94–103. https://doi.org/10.1016/j.jht.2012.12.007;

Muresan, A. (2005). *Volei în învățământul liceal*, Ed. G.M.I, Cluj-Napoca;

Muresan, A. (2005). *Volei Selecția și Pregătirea Echipelor de Juniori*, Ed. G.M.I., Cluj-Napoca;

Muresan, A. (2005). *Volei Strategie-Tactica*, Ed. Accent, Cluj-Napoca;

Musa, D.I. și Toriola A.L. (2006). Estimation of power output from vertical jump: A comparison of three prediction equations. *Journal of Human Movement Studies*. 51. 11-20;

Mustafa, K. (2011). A Comparative Study: Differences between Early Adolescent Male Indoor Team Sports Players' Power, Agility and Sprint Characteristics. *Ovidius University Annals, Series Physical Education and Sport / SCIENCE, MOVEMENT AND HEALTH*, Vol. 11, ISSUE 2, 2011, Romania;

Nasuka N. (2020). The Anthropometric Profile and Motor Skill of Men Elite Volleyball Players. *Health, and Physical Education*, January 2020, DOI:10.2991/ahsr.k.200214.010;

Ohuruogu, B., Jonathan, U.I. și Ikechukwu, U. (2016). Psychological Preparation for Peak Performance in Sports Competition. *Journal of Education and Practice*, 7, 47-50;

Palao, J.M., Manzanares, P. și Valades, D. (2014). Anthropometric, Physical, and Age Differences by the Player Position and the Performance Level in Volleyball. *Journal of Human Kinetics*. 44. 223-236. 10.2478/hukin-2014-0128;

Palao, J.M., Santos, J.A. și Ureña, A. (2004). Effect of team level on skill performance in volleyball, *International Journal of Performance Analysis in Sport*, 4:2, 50-60, DOI: 10.1080/24748668.2004.11868304;

Pereira, A., Costa, A., Santos, P., Figueiredo, T. și João, P. (2015). Training Strategy of explosive strength in youth female volleyball players in high school. *Medicina (Kaunas, Lithuania)*. (in press). 10.1016/j.medici.2015.03.004.);

Pereira, G., de Freitas, P., Rodacki, A., Ugrinowitsch, C., Fowler, N. și Kokubun, E. (2009). Evaluation of an Innovative Critical Power Model in Intermittent Vertical Jump. *International Journal of Sports Medicine*. 30. 802-807. 10.1055/s-0029-1231071;

Perez-Gomez, J. și Calbet, J. (2013). Training methods to improve vertical jump performance. *The Journal of sports medicine and physical fitness*. 53. 339-357;

Petrigna, L., Karsten, B., Marcolin, G., Paoli, A., D'Antona, G., Palma, A. și Bianco, A. (2019). A Review of Countermovement and Squat Jump Testing Methods in the Context of Public Health Examination in Adolescence: Reliability and Feasibility of Current Testing Procedures. *Frontiers in physiology*, 10, 1384. https://doi.org/10.3389/fphys.2019.01384;

Poenaru, A. (2006) Volei Tactica Teorie Metodica, Ed. Risoprint, ClujNapoca;

Polakovičová, M., Vavák, M., Ollé, R., Lehnert, M. și Sigmund, M. (2018). Vertical jump development in elite adolescent volleyball players: Effects of sex and age. *Acta Gymnica*. 48. 10.5507/ag.2018.016;

Pueo, B., Penichet-Tomas, A. și Jimenez-Olmedo, J.M. (2020). Validity, reliability and usefulness of smartphone and kinovea motion analysis software for direct measurement of vertical jump height. *Physiology & Behavior*, 227;

Quagliarella, L., Sasanelli, N., Belgiovine, G., Moretti, L. și Moretti, B. (2010). Evaluation of Standing Vertical Jump by Ankles Acceleration Measurement, *Journal of Strength and Conditioning Research*: Volume 24 - Issue 5 - p 1229-1236 doi: 10.1519/JSC.0b013e3181cb281a;

Rantalainen, T., Finni, T. și Walker, S. (2020). Jump Height from Inertial Recordings : A tutorial for a Sports Scientist. *Scandinavian Journal of Medicine and Science in Sports*, 30 (1), 38-45. DOI: 10.1111/sms.13546;

Reynaud, C. (2011). Coaching volleyball technical and tactical skills, American Sport Education Program, *Human Kinetics*, ISBN-13: 978-0-7360-5384-6.

Reynaud, C. (2015) The Volleyball Coaching Bible, VO L U M E I I, *Human Kinetics*, United States;

Rodriguez-Ruiz, D., Quiroga, M., Miralles, J., Sarmiento, S., de Saá, Y. și García-Manso, J. (2011). Study of the Technical and Tactical Variables Determining Set Win or Loss in Top-Level European Men's Volleyball. *Journal of Quantitative Analysis in Sports*, 7(1). https://doi.org/10.2202/1559-0410.1281;

Roman, B., Sergii, I. și Nosko, M. (2017). Pedagogical conditions of motor training of junior volleyball players during the initial stage. *Journal of Physical Education & Sport* . Mar 2017, Vol. 17 Issue 1, p327-334. 8p;

Roman, G. și Batali, F. (2007). Antrenament sportiv. Teorie si metodica, Ed.Napoca Star, Cluj-Napoca;

Ruan, M. și Li, L. (2010). Approach run increases preactivation and eccentric phases muscle activity during drop jumps from different drop heights. *J Electromyogr Kinesiol*, 2010; 20: 932-938;

Salim, F. A., Haider, F., Yengec Tasdemir, S. B., Naghashi, V., Tengiz, I., Cengiz, K., Postma, D. B. W., van Delden, R., Reidsma, D., Luz, S., și van Beijnum, B-J. (2020). Volleyball Action Modelling for Behavior Analysis and Interactive Multi-modal Feedback. In *eNTERFACE'19, 15th International Summer Workshop on Multimodal Interface*, Bilkent University;

Sandor, I. (2005). Antrenamentul la altitudine, Ed. Risoprint, Cluj-Napoca;

Sattler, T., Sekulic, D., Hadzic, V., Uljevic, O. și Dervisevic, E. (2012). Vertical jumping tests in volleyball: reliability, validity, and playing-position specifics. *Journal of strength and conditioning research*, 26(6), 1532–1538. https://doi.org/10.1519/JSC.0b013e318234e838;

Saunders, H.L. (1980). A cinematographical study of the relationship between speed of movement and available force. *Unpublished doctoral dissertation*, Texas A&M University, College Station;

Săvescu, I. (2009). Educatie Fizica, *Ghid orientativ pentru titularizare, definitivat și gradul II*, Ed. Aius Prin, Craiova;

Savu, C. și Pehoiu, C. (2018). Developing Speed by Means of Volleyball in Physical Education Lessons in the Gymnasium Cycle. *Revista Romaneasca Pentru Educatie Multidimensionala*, *10*(1), 136-144. https://doi.org/10.18662/rrem/24;

Sayers, S. P., Harackiewicz, D. V., Harman, E. A., Frykman, P. N. și Rosenstein, M. T. (1999). Cross-validation of three jump power equations. *Medicine and Science in Sports and Exercise*, 31, 572–577;

Sian, A. și Hopkins, W. (2014). Age of Peak Competitive Performance of Elite Athletes: A Systematic Review. *Sports medicine (Auckland, N.Z.)*. 44. 10.1007/s40279-014-0239-x;

Šimonek, J., Horička, P. și Hianik, J. (2017). The differences in acceleration, maximal speed and agility between soccer, basketball, volleyball and handball players. *Journal of Human Sport and Exercise*, 12(1), 73-82. doi:10.14198/jhse.2017.121.06;

Soundara, R. și Pushparajan, A. (2010). Effects of plyometruc training on the development the vertical jump in vollleyball players. *Citius Altius Fortius.* 28;

Stöckl, M., Plück, D. și Lames, M. (2017). Modelling game sports as complex systems – application of recurrence analysis to golf and soccer, *Mathematical and Computer Modelling of Dynamical Systems,* 23:4, 399-415, DOI: 10.1080/13873954.2017.1336635;

Stojanović, N., Jovanovic, N. și Stojanovic, T. (2012). The effects of plyometric training on the development of the jumping frequency of volleyball players. *Facta universitatis, Series: Physical Education and sport*. 10. 59-73;

Stupar, R.C., Monea, Gh. și Șanta, C. (2021). U17 Romanian Volleyball Player's Approach Height Analysis, Related To The Jump Index As A Performance Indicator, *7th International Conference of the Universitaria Consortium in Physical Education, Sports and Physical Therapy,* pag. 112

Suresh, T.N., Begum, R., Meeran, N., Sivakumar, V., Pharma Int și Sci Bio. (2017). Effect of plyometric exercise training on vertical jump height between ground and sand surface in male volleyball players. *International Journal of Pharma and Bio Sciences.* 8(3). 163-169;

Szabo, D.A., Neagu, N.E., Voidăzan, S., Sopa, I.S. și Gliga, C. (2019). Analyzing the attack players in volleyball through statistical methods. *Health, Sports & Rehabilitation Medicine, Vol. 20, no. 4,* October-December, 154–158;

Tai, W. H., Wang, L. I., și Peng, H. T. (2018). Biomechanical Comparisons of One-Legged and Two-Legged Running Vertical Jumps. *Journal of human kinetics.* 64, 71–76. https://doi.org/10.1515/hukin-2017-0185;

Tarchilă N. și Șerban M., (1975). Volei pentru juniori, Ed Sport-Turism, Bucuresti

Taware, G.B., Bhutkar, M., și Surdi, A.D. (2013). A Profile of Fitness Parameters and Performance of Volleyball Players. *Journal of Krishna Institute of Medical Sciences University*. 02, 48-59;

Taylor, M., Cohen, D., Voss, C. și Sandercock, G. (2010). Vertical jumping and leg power normative data for English school children aged 10-15 years. *Journal of sports sciences*. 28. 867-72. 10.1080/02640411003770212;

Toselli, S. și Campa, F. (2018). Anthropometry and Functional Movement Patterns in Elite Male Volleyball Players of Different Competitive Levels. *Journal of strength and conditioning research.* 32(9), 2601–2611. https://doi.org/10.1519/JSC.0000000000002368;

Trajković, N. și Bogataj, Š. (2020). Effects of Neuromuscular Training on Motor Competence and Physical Performance in Young Female Volleyball Players. *Int J Environ Res Public Health*. 17(5):1755. Published 2020 Mar 8;

Tricoli, V., Lamas, L., Carnevale, R. și Ugrinowitsch, C. (2005). Short-Term Effects on Lower-Body Functional Power Development: Weightlifting vs. Vertical Jump Training Programs. *Journal of strength and conditioning research / National Strength & Conditioning Association*. 19. 433-7. 10.1519/R-14083.1.

Vint, P. și Hinrichs, R. (1996). Differences between One-Foot and Two-Foot Vertical Jump Performances. *Journal of Applied Biomechanics*. 12. 338-358. 10.1123/jab.12.3.338.

Wesselly, T., Mesei, M., Florescu, O., Neagu, N. și Pricop, A. (2019). Optimisation of explosive strenght in beginer female volleyball players, *Physical Education, Sport and Kinetotherapy Journal,* DOI: 10.35189/iphm.icpesk.2019.53

Zabchi, N., Mokrani, D., Benzidane, H. și Sebbane, M. (2016). The Effect of the Contrastive Training Using Weights and Plyometrics on the Development of the Vertical Jump Ability to Improve the Performance of the Smash for Volleyball Players. *Evropejskij Žurnal Fizičeskoj Kul'tury i Sporta*. 11. 10.13187/ejpe.2016.11.24.

Zemam, A. (2019). Effects Of Plyometric Exercises With Repetition Training Method On Vertical Jump Performance And Soccer-heading Skills, *The journal « sports creativity » Volume: (10) / N°: (02)-(2019), p 121-139,* http://dspace.univ-msila.dz:8080//xmlui/handle/123456789/19396.

Online reference sources

Volei (n.d.). A Brief History of Volleyball Timeline
https://www.improveyourvolley.com/brief-history-of-volleyball.html
data accesării 25.10.2019 ora 19:00
Big H. (2010). A BRIEF HISTORY OF VOLLEYBALL
http://www.bighistory.net/a-brief-history-of-volleyball/
data accesării 25.10.2019 ora 19:20
Volei (2015). Volleyball: a brief history
https://olympics.com/ioc/news/volleyball-a-brief-history/
data accesării 25.10.2019 ora 19:40