„BABES-BOLYAI" UNIVERSITY OF CLUJ-NAPOCA

FACULTY OF PHYSICAL EDUCATION AND SPORTS

DOCTORAL SCHOOL

Ph.D. THESIS SUMMARY

EFFICIENCY ENHACEMENT OF THE SPIN SHOT IN JUNIOR I BEACH HANDBALL – THE INFLUENCE OF GROUND FORCES

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2023

Gratitude

With great pleasure, I express my sincere gratitude for the support, guidance, and inspiration I have received throughout the completion of this doctoral thesis. This moment represents a significant milestone in my academic and professional life, and these words of thanks cannot fully encompass my gratitude to all those who have contributed to this success.

First and foremost, I would like to thank my doctoral supervisor, Prof. Dr. Iacob Hanțiu, for his guidance, patience, and support during my research. Without his clear and wise guidance, this thesis could not have met the high academic standards set by the institution.

I also wish to express my deep appreciation for my doctoral thesis advisory committee, consisting of Prof. Dr. Emilia Florina Grosu, Prof. Dr. Leon Gomboș, and Prof. Dr. Gheorghe Monea. Your feedback and suggestions were invaluable in the process of improving this thesis.

I would not have been able to complete this thesis without the support of my family and friends who provided moral and emotional support throughout this academic journey. Equally, I want to thank Dr. Adrian Pătrașcu, Coach Rodica Petruș, and the athletes at C.S.S. Viitorul Cluj, with whom I collaborated throughout our research.

In conclusion, I want to emphasize that this doctoral thesis is the result of collective effort and support from numerous individuals. I am grateful for this experience and for all the lessons learned throughout this process. Thank you once again to all those who have been with me on this academic and professional journey.

List of published scientific papers

1. Macra-Oșorhean, M.D.; Radu, P.O.; Petruș, R.C.; Rozsnyai, R. A. (2022). Beach Handball – The Effect Of The Sand Surface On Explosive Force In The Training of Handball Indoor Players at Juniors Level (16-18 Years Old). *Education for Health and Performance: proceedings of ICU 2022 – the 8th International Conference of the Universitaria Consortium*, pp. 239-246, ISBN 978-606-37-1783-3.
2. Radu, P.O.; Macra-Oșorhean M.D.; Petruș, R.C.; Toma, A. (2022). The Physiological Effects Playing Beach Handball Has On Junior Handball Indoor Players. *Studia UBB Educatio Artis Gymnasticae,* LXVII, 4, pp. 89-96, ISSN 1453-4223, http://www.studia.ubbcluj.ro/download/pdf/educatio/2022_3/07.pdf;
3. Radu, P.O.; Pătrașcu, A.; Hanțiu, I. (2022). Throwing Procedures Used at The European U17 Beach Handball Championships. *Studia UBB Educatio Artis Gymnasticae,* LXVI, 2, pp.41-52,ISSN1453-4223, http://www.studia.ubbcluj.ro/download/pdf/educatio/2022_2/04.pdf;
4. Radu, P.O.; Pătrașcu, A., Hanțiu, I. (2023). Spinshot Throw in U18 Juniori Beach Handball: The Effect of Ground Forces. *Analele Universității din Oradea. Fascicula Educație Fizică și Sport*, XXXIII, 33102-878, pp. 13-20, ISSN 2286-2870, https://www.fefs.uoradea.ro/Fascicula_Educatie_Fizica_si_Sport/2023/2.FEFS_2023_Hantiu.pdf;

Keywords: **beach handball, ground forces, junior I, sports training, kinovea, force platform**

Cuprins

Introduction

One of the newly emerging sports internationally is beach handball, aiming to be more spectacular than traditional handball. The first recorded data on beach handball dates back three decades. Earlier attempts to play on the beach are known, but the first organized competitions were recognized in the early 1990s.

This game finds its origins in Italy in the early 1990s, driven by the desire to replace the training period between competitions with an active one, where athletes could relax, socialize, and, most importantly, maintain their performance at an optimal level (Espina, 2008; Trespidi & Gehrer, 2008; Rokavec, 2009; Almeida et al., 2012; Belka et al., 2015; Cobos et al., 2018).

Due to its growing development as a sport, more and more athletes, including traditional handball players and sports enthusiasts, have embraced the name "beach handball" and started playing it more often (Zapardiel, 2018).

At present, high-performance beach handball has seen significant growth, making it increasingly necessary to approach it from all scientific aspects. The continuous development of the game has prompted theorists and practitioners to research its issues and content, as well as the orientation of the training process (Bebetsos, 2012).

The dynamic development of beach handball, along with the increasing interest from the public, has led to the professionalization of top teams, directly impacting the transformation of the basic characteristics of this new sport.

The dynamic nature of the game makes it fascinating to watch, with the speed of its actions on the field and the simplicity and courage of executing specific goal-throwing techniques, such as aerial or spinning throws.

Beach handball is an educational tool that contributes to the development of students' motor skills, promotes values like respect and fair play, thus fostering their overall development (Hita, 2016).

Although beach handball has experienced rapid growth and increased interest over the last two decades, it is still considered a "sport of the future." Among the specific rules of this new sport, created to be more spectacular than indoor handball, there are double points awarded for goals scored from aerial or spinning throws, as well as for goals scored by goalkeepers from one

end to the other. Beach handball is characterized by a combination of high-intensity efforts, such as rapid accelerations with short breaks.

The completion of this work will expand the field of knowledge about the object of study, beach handball, a sport that has experienced significant growth in recent years, both nationally and internationally, and has attracted the interest of specialists (Morillo-Baro et al., 2018; Penichet-Tomas et al, 2019; Saavedra et al., 2019).

This doctoral thesis presents specific approaches to improving athletic performance in beach handball, focusing on decisive actions in the game, such as strength, execution speed, jump height, and coordination.

The destiny of beach handball, as well as its regulations, is determined by the International Handball Federation. The game's regulations and its evolution over time show that in all game actions, both individual and collective, the spirit of FAIR PLAY is required to be upheld.

Motivation of this research

The theme addressed in this research is motivated by the fact that the technical techniques of scoring a 2-point goal throw can make a difference in a game. Beach handball teams are in continuous evolution, and the game as well. The value of those competing for the top positions is very close. When comparing the results obtained in various major competitions, it is evident that they are relatively equal. Coaches emphasize the repetition of technical and tactical actions, relying on a good understanding of the teams they encounter, thus preparing specific two-point throws to increase their efficiency.

After studying the specialized literature, we found that both nationally and internationally, there is a limited scientific approach even to the development of the game through specific training methods aimed at achieving performance in beach handball, and it is virtually non-existent in our country.

We believe that the theme addressed can support coaches with training tools and methods to improve athletic performance because, in certain key moments, the absence of these technical finishing procedures and their efficiency can influence the course of a game.

This study can contribute additional information to the national specialized literature by developing a methodology that encompasses means and methods to enhance the spinshot goal throw technique.

PART I

Chapter 1. Theoretical and practical foundations of beach handball

All sports and athletic disciplines that are practiced today, whether for leisure or in competitive settings, started outdoors. Some of them, due to their evolution, are now practiced indoors under the label "indoor."

The current trend and people's desire to spend more time outdoors, especially during vacations or holidays, bring back sports to their "origins," practicing them outside of sports halls, particularly on beaches.

Soccer, volleyball, and handball are among the most popular team sports worldwide, with over 300 million registered players (Krutsch et al., 2020). These three sports have a well-organized competitive system, ranging from local amateur matches to large-scale international competitions such as the Olympics, World Championships, and European Championships.

From these "classic" team sports, other beach variants have emerged, namely beach soccer/football, beach volleyball, and beach handball, which fall under the auspices of organizations such as FIFA (soccer), FIVB (volleyball), and IHF (handball). Despite being called "beach," these sports are not only played in beach areas but also in other locations, such as marketplaces that can accommodate a large number of spectators.

Over time, these new branches or sports disciplines were initially played on sand for enjoyment, and the introduction of their official beach variants offered new sets of rules for each sport, leading to their rapid rise in popularity worldwide.

Sports played on sand offer a greater variety of actions during matches, smaller-sized courts, fewer players, and uninterrupted playing time, resulting in a higher quality of actions and players maintaining a high level of performance. The fast pace of the games and the involvement of each player in all actions lead to an increased level of effort in beach sports compared to traditional sports such as soccer, handball, volleyball, tennis, and rugby.

Physiological changes can be observed and measured in games played on sand. Studies have shown that in more than half of the time during a match, heart rate is maintained at 90% of maximum capacity, requiring large amounts of energy through the anaerobic system (Scarfone et al., 2009). Endurance can also be measured by analyzing catecholamines, representing an indicator of competitive stress modulation (after cortisol and testosterone) and being extracted through urine

(Takagi et al., 2020). A study conducted on junior handball players who also practice beach handball revealed that switching from one sport to the other does not affect their physiological status (Radu et al., 2022).

Experts have pointed out that there are differences in body movements and energy consumption during various actions performed on sand or similar surfaces compared to hard surfaces where handball or volleyball is practiced. Studies analyzing walking and running on sandy surfaces have reported differences in mechanical work and energy consumption (Zamparo et al., 1992; Lejeune et al., 1998; Pinnington & Dawson, 2001; Davis & Mackinnon, 2006). Sand reduces maximum force and maximum power achieved because it absorbs the energy's impulse (Bishop, 2003; Giatsis et al., 2004; Castellano & Casamichana, 2010).

Sports played on sand are considered safer compared to those played on other surfaces (grass, parquet, etc.), and when injuries do occur, they tend to be minor and specific, such as skin abrasions caused by sand friction (Achenbach et al., 2018).

SYNTHESIS Chapter 2. Beach handball game

The results and feedback from the European Beach Handball Championships (female and male), which began in 2000, clearly demonstrated significant interest in the game of beach handball. With each championship, the development of beach handball has grown, and the interest from teams and spectators has been evident.

Youth championships were first held in 2008 and have been played every two years since. The first European Beach Handball U18 Championship was hosted by Hungary in the city of Nagyatad, which was located for the first time in the history of Beach Handball Championships on a coast, presenting a unique challenge.

In 2011, Croatia hosted the European U19 Championships for the first time. In the female final, Hungary defeated Russia, while Croatia claimed the title in the male competition, also against Russia. Croatia's female team finished in third place on the podium that year.

In 2019, Poland organized the European Youth Championship, with Spain winning in the female category and Hungary in the male category. Romania participated for the first time, with the female team finishing in 14th place and the male team in 7th place, after being defeated by Poland (2-1) and Ukraine (2-0) in the 5-8 placement matches.

At the Youth Olympic Games held in Buenos Aires, Argentina, in 2018, Beach Handball made its debut among other established sports. This was considered a significant success and a first step for the sport to achieve its Olympic dream.

This game is accessible to all and can be played by children and young people of both genders, as well as adults. The rules are simple and easy to understand, making it suitable for beginners. It is played on a 40cm sand surface, lightly watered in very hot weather, and is played outdoors. The field dimensions are 27m x 12m, and the game is played with three outfield players and one goalkeeper for each team. A match consists of two halves, each lasting 10 minutes. The winner of a set is the team with more points at the end of it. In the case of a tie between sets, a "golden goal" is played. If a team wins both sets, they are declared the winner. If the sets remain tied, 5 "shoot-out" throws are executed.

One of the significant characteristics of beach handball is the lack of familiarity with its playing surface. Due to this, players not only do not perform typical individual technical actions from traditional handball, such as dribbling or jumps, but they also encounter other less common actions in this sport, such as aerial or spinshot throws (Saavedra, 2019; Gruic, 2011).

Teams are typically in numerical superiority when on the attack; they remove the goalkeeper and include the "specialist" player whose throws are scored with two points when they score a goal (Almeida et al., 2012).

Compared to traditional handball, beach handball players cover a shorter running distance (handball: men - approx. 3620m, women - approx. 4000m; beach handball: men - 1200m, women - 1100m) (Michalsik & Aagaard, 2015; Puebo et al., 2017), as well as fewer accelerations on the sand surface.

Beach handball is played on a smaller field, on sand, and with fewer players (3 + 1 goalkeeper). The game's rules are designed to make it as attractive, unpredictable, and interesting for both players and spectators (Gruic et al., 2011; Rokavec, 2009; Belancic, 2005).

The ball used in the game is made of non-slip rubber. In men's competitions, it weighs between 350-370 grams and has a circumference of 54-56cm, while in women's competitions, the ball weighs between 280-300 grams and has a circumference of 50-52cm (www.ihf.com).

The winning team is determined at the end of the two halves. Each half requires a winning team. In case of a tie in a half, a "Golden Goal" is played, where the first team to score a goal wins the half.

In the event of a 1-1 tie in sets, a shoot-out will follow, where each team has 5 throws, and the winner is determined at the end of this round (2-1). If there is still a tie after these throws, additional throws will follow until one team is ahead by one goal after an equal number of throws, determining the match's winner (eurohandball-beachtour.com).

SYNTHESIS Chapter 3. Attacking techniques in beach handball

The technique requires increased attention, where the precision and speed of attacking actions (and more) must correspond to the diversified situations in the game. We can say that any attacking action, in our case, throwing the ball into the goal from a spinshot, leads to the development of goal-scoring ability and, consequently, to the formation of correct skills for performing this technical procedure.

Technique, in a sports discipline, represents the "totality of motor actions executed ideally in terms of their efficiency" (Dragnea & Mate-Teodorescu, 2002), and according to other authors, "technique represents the degree of mastering an exercise in relation to the model" (Sabău, 2001). Mastering a comprehensive technical repertoire becomes a constant necessity, both in the desire to entertain and in the need for variety in procedures, precision of actions because effectiveness is achieved through the final movements in front of the goal, where space is limited, and time is constrained due to aggressive and crowded defenses (Cojocaru, 2001).

Achieving sports performance in beach handball depends on the physical and psychological abilities of athletes and the team's level. The player's performance depends on certain movements that involve speed and strength, rapid accelerations and decelerations, and changes of direction (Puebo et al., 2017; Cobos, 2011; Hughes & Bartlett, 2002), while the team's performance depends on the technique and tactical performance indicators of the team, such as passing, catching, throwing, blocking, etc., in offensive and defensive situations encountered during a game (Wagner et al., 2014; Belka et al., 2015).

The outcome during the game is determined by the final phase of a player's attack – the throw. This is dependent on many factors, especially technical execution factors that involve regular and rational movements, tactical factors, and the limited execution time (Srhoj et al., 2012). The throw into the goal is one of the fundamental elements of the game on which the individual and collective performance of a team can depend. By their nature, in game conditions, these require meticulous preparation and exceptional skills from the players (Trofin, 1970).

The success of a throw into the goal depends not only on the player's muscular strength but also on other aspects such as segment coordination and acquired technique.

Throwing into the goal from spinshot

This technical throwing procedure can be executed from anywhere on the beach handball field (outside the goalkeeper's area) and is a straight throw, almost in the direction of movement. This throw can be preceded by a pass, dribbling, and then the actual throw.

Regardless of which foot catches the ball, the throw is performed from both feet, after one or two steps. The feet serve as points of support on the ground, while the trunk and the throwing arm are twisted in the direction of the throwing arm, ensuring that their rotation forward provides the necessary force for executing the spinshot and the subsequent throw.

The effectiveness of the throw depends on the execution speed, the force applied by the legs, the abdominal contraction strength, and the tendency for progressive acceleration, so that at the final moment of the rotation, the whip of the arm is at maximum intensity.

We have attempted to summarize the data collected regarding the throwing procedures from European or World Beach Handball Championships, both at the senior and youth levels.

From various studies conducted by other specialists, it appears that boys have stronger throws than girls (Zapartidis et al., 2007; Ettema et al., 2008; Fabrica et al., 2008; Granados et al., 2008). They conclude that physical characteristics such as height, weight, body mass index, and isometric strength explain the differences in throws between the two genders. Boys throw faster and produce more force due to their height.

A comprehensive analysis has been conducted for almost every edition of a final tournament. The research shows that specific procedures for scoring 2 points have been increasing year by year. Senior men's teams focus on goals scored from spinthrows - over 40% in each year (exception in 2009 - 38.21%), aerial throws - over 20% (exception in 2011 - 6.06%), or by specialists, including the goalkeeper - over 17% (Gehrer et al., 2006; Konig et al., 2008; Gehrer & Posada, 2010; Gruic et al., 2011).

SYNTHESIS Chapter 4. General aspects of sports training

Sports training is closely related, through an interdependent relationship, to the concepts of sports, competition, and athletic performance. From this perspective, sports training should benefit from the scientific advancements of fundamental research, as it can significantly impact its orientations through the specific responses obtained in achieving athletic performances. Sports training is an integrated and determining part of the preparation of athletes practicing beach handball.

In the specialized literature, various domestic authors conceive the notion of sports training as a "systematic pedagogical process with the aim of adapting the body to intense psychophysical efforts involved in competitive participation" (Dragnea, 1996). Alexe (1993) considers sports training as a "systematic and continuously graded pedagogical process, aimed at adapting the human body to technically-tactical and intense psychophysical efforts to achieve high results in one of the forms of competitive physical exercise." Apostol (1998) and Drăgan (1994) define sports training as "the set of demands placed on the body, which determine its morphological and functional adaptation by increasing its capacity for effort." Bompa (2002) specifies that "sports training is, first and foremost, a systematic sports activity, of long duration, progressively and individually graded."

Beach handball, like traditional handball, is currently experiencing continuous development, enriching its technical-tactical repertoire with new elements in each international competition, demonstrating real perspectives far from stabilization.

The analysis of definitions shows that the sports phenomenon is a result of the interaction between interdisciplinary fields, both in structure and methods, but also through the set of laws and principles that underlie and condition sports training (Rizescu, 2008).

In many sports disciplines, an athlete's ability to jump is closely related to athletic performance. A significant number and variety of technical motor actions rely on the lower body's ability to generate the greatest amount of force in the shortest possible time or, at the very least, at the speed at which the motor action is executed (Gonzalez-Badillo & Gorostiaga, 1997).

Increasing the muscular strength of the lower body is closely related to improving vertical jumping (Hakkinen et al., 1986; Adams et al., 1992; Schmidtbleicher, 1992), which, in turn, is

essential in performing various actions encountered in beach handball, such as movements, jumps, speed, etc.

Zatsiorsky & Kramer (2006) define explosive strength as the "ability to produce maximum force in the shortest time possible," and the index of explosive strength is calculated using the following formula: Maximum force (Fmax) * time allocated to produce the maximum force (Tmax).

Plyometrics is one of the methods that positively influence the improvement of explosive strength. It represents a natural movement in many sports because it involves jumping (Bauer et al., 1990). Some authors suggest in their research that plyometrics also have a positive influence on agility, which shares characteristics similar to jumping or other explosive strength movements (Simek et al., 2008; Heang et al., 2012).

Plyometrics has represented a method for developing muscle power for a long time, particularly through its practical side and less through the theoretical side. Recently, it has gained a theoretical basis (Dumitrescu & Călinescu, 2006).

The plyometric method has been identified as effective in improving muscle and joint control, balance, and neuromuscular properties, both in the pre-competitive and competitive periods (Arazi & Asadi, 2011; Asadi et al., 2015).

By using these types of exercises, athletes experience a level of tension and contraction speeds they are not typically exposed to, which forces them to tap into their available energy resources that are less frequently used.

In the specialized literature, Verkhoshansky & Siff (2009) highlight several types of plyometric training, similar to the intensity used by weightlifters, where the dosing of exercises is calculated as a percentage of 1RM (one-repetition maximum).

Plyometric training can be divided as follows:

- Maximal Plyometric Training: Characterized by a low number of repetitions, and the intensity of deep jumps produces an almost maximal muscle tension rebound. These powerful impulses are not meant to be used in every workout or with multiple repetitions.
- Sub-maximal Plyometric Training: Characterized by a training form involving mechanical impulses but not producing maximal muscle tension.

SYNTHESIS Chapter 5. The characteristics of the bio-psycho-motor development of female beach handball players (aged 16-18 years)

In order for the players to reach and maintain a high level of performance, training programs should incorporate knowledge from various interdisciplinary fields such as sports physiology and sports medicine (Ziv & Lidor, 2009). Information related to training, such as anthropometric measurements of beach handball players (Noustus et al., 2008), physiological characteristics (Ramadan et al., 1999), the speed and accuracy of throws (van den Tillar & Ettema, 2003, 2004, 2006), and on-field performance (Luig et al., 2008), can be effectively used in specific training programs for the game (Ziv & Lidor, 2009).

According to Hantău (2004), growth and development are simultaneous processes in children, with growth following its own laws, and "developmental stages represent periods in the age of a child or adolescent, distinct from each other in terms of morpho-physiological characteristics dictated by the somatic and vegetative evolution of the organism."

In the second phase of puberty, there is a progressive slowing down to a halt of all indicators of bodily growth. The basis for improved performance is a well-developed musculature and good neuro-motor coordination. At the end of the adolescent stage, around the ages of 17-19, the growth process stops for girls, while it continues for boys until they reach ages 21-25 (Rizescu, 2008).

The biological, functional, and psychological characteristics demanded by contemporary handball recommend an optimal age (Bota & Bota, 1987).

In our research, we consider it important to analyze and address the level of bio-psycho-motor development of female juniors aged 16-18, as a profound understanding of these developmental characteristics is essential for their success.

The importance of obtaining accurate information about the morphology, biological maturation, and functional development of children and young handball players is documented in the literature. In recent decades, studies have attempted to gather and systematize information to characterize and understand the sports training of young female handball players.

At this age, "the increase in muscle strength and the very high capacity to stimulate and fix motor patterns create optimal conditions for improving performance. Because during the second

phase of puberty, physical condition and coordination can be trained in parallel with maximum intensity, this represents a new phase of motor performance improvement" (Weineck, 1992).

From a cardiovascular perspective, beach handball players are pushed to their maximum in every game. The intensity and duration of the game are such that good physical preparation is required to play a whole match.

At the age of 18, vital capacity reaches 4000-4500 cm, the respiratory rate is 15-18 breaths per minute, red blood cells reach 4.5-5 million, and white blood cells number between 6000-7500, with a hemoglobin level of 80-97%, values close to that of an adult (Rowell, 1986; Richter et al., 1988; Roth, 1991).

The adolescent period is characterized by Grosu (2009) as a "general stabilization of gestural conduct, improvement of motor skills for guidance, adaptation, readaptation, and combination. Motor learning capacity is higher in boys than in girls."

This period of adolescence is marked by intense psychological and personality development among athletes, forming new stereotypes and means of relating to those around them. During this stage, self-awareness characteristics are developed, with difficulties regarding concentration capacity and fatigue during efforts among female athletes (Verza, 2000).

Drăgan (1989) mentions in his work that "the tendency for self-assertion and expression generates a blend of affective experiences. Adolescents want to appear and act differently than they are asked, with psychologists categorizing all these manifestations as a 'youth crisis'."
Fluctuations in self-confidence are significant at the adolescent age, depending on the success or failure they encounter. There is opposition to adult prohibitions, manifestations of stubbornness, and aggressive reactions (Ciobanu, 2005; Rață, 2008).

During adolescence, transformations occur, with most of the psychic structures crystallizing and stabilizing. Authors such as Epuran (1992) and Stoica (2001) affirm that "the paths of psychic development processes are complex and fraught with many barriers and difficulties. Although the process can be a calm one or not, with spectacular advances but also with spectacular delays, at the end of this process, the structures will be well-structured and cohesive with a high degree of mobility."

PART III

SYNTHESIS Chapter 6. Study I – Statistical analysis of the percentage and efficiency of throws on goal in teams participating in the U17 European Beach Handball Championships in 2019 and 2021

6.1 Research purpose

The purpose of this research was to investigate the technical shooting techniques used and the efficiency of these throws in the teams that ranked in the top three positions at the U17 European Beach Handball Championships in 2019 and 2021, as well as the Romanian U17 national team.

6.2 Research objectives

- Analyze the percentage and efficiency of throws for each team placed on the podium of the European Youth Beach Handball Championship in 2019 and 2021.
- Identify the level of performance of the Romanian women's youth representative team at the European Beach Handball Championship in 2019 and 2021 in the context of the research's objectives.

6.3 Research organization

To efficiently manage the goal-scoring actions, observation sheets were completed during the viewing of beach handball matches at the European Beach Handball Championships in 2019 and 2021. The recorded variables in the observation sheets included Spinshot shot (Pir_Ar), Goal from a spinshot (Pir_G), Aerial shot (Aer_Ar), Goal from an aerial shot (Aer_G), Specialist's goal attempt (Spc_Ar), Goal scored by a specialist (Spc_Goal), Goal-to-goal shot (DiG_Ar), Goal scored from goal to goal (DiG_G), 6-meter shot (6m_Ar), Goal from 6 meters (6m_G), 1-point shot (1p_Ar), Goal scored with 1 point (1p_G).

Statistical data analysis was performed using the SPSS Statistics 17 program. Indices such as minimum, maximum, mean, standard deviation, and variation were calculated. After obtaining these indices, we analyzed the values descriptively between the two editions of the U17 European Beach Handball Championships.

6.4 Research results

Table 1.
Statistical analysis of data fot the spinshot throw at the goal

Teams		Year	N	Min.	Max.	Media	D. Standard	Variance	Total Thr./Gol.
I	Pir_%	2019	6	71	100	82.18	10.53	110.79	
		2021	6	64	79	72.95	6.22	38.75	
	Pir_Ar	2019	6	7	10	8.50	1.05	1.10	51
		2021	6	9	14	12.00	1.79	3.20	72
	Pir_G	2019	6	5	8	7.00	1.26	1.60	42
		2021	6	6	11	8.83	1.94	3.77	53
II	Pir_%	2019	6	67	100	87.50	14.67	215.34	
		2021	6	71	83	75.65	4.27	18.22	
	Pir_Ar	2019	6	4	6	5.00	1.10	1.20	30
		2021	6	12	24	16.50	4.46	19.90	99
	Pir_G	2019	6	3	6	4.33	1.03	1.07	26
		2021	6	9	18	12.50	3.51	12.30	75
III	Pir_%	2019	6	83	100	92.06	8.74	76.38	
		2021	6	68	80	72.86	3.90	15.18	
	Pir_Ar	2019	6	3	7	5.33	1.51	2.27	32
		2021	6	18	21	19.67	1.21	1.47	118
	Pir_G	2019	6	3	6	4.83	1.17	1.37	29
		2021	6	13	16	14.33	1.21	1.47	86
Ro	Pir_P%	2019	6	28.6	50.0	37.60	7.74	59.97	
		2021	7	25.0	94.7	56.94	21.79	474.71	
	Pir_Ar	2019	6	4	8	6.33	1.37	1.87	38
		2021	7	4	26	14.57	7.37	54.29	102
	Pir_G	2019	6	2	3	2.33	0.52	0.27	14
		2021	7	1	18	9.29	6.37	40.57	65

Notă: Pir = Aruncare din piruetă; Ar = Aruncare; % = Procentaj, G = gol.

In 2019, the team that finished first at the European Beach Handball U17 Championships had a total of 51 spinshot throws at the goal, of which 42 were goals, resulting in 84 points. In 2021, the first-place team had 71 throws at the goal, scored 56 goals, and earned 112 points. The second-place team in both 2019 and 2021 had 30 spinshot throws at the goal, with 26 goals and 52 points in 2019, and 118 throws, 86 goals, and 172 points in 2021. The third-place team in 2019 had 38 spinshot throws at the goal and scored 14 goals, earning 28 points. In 2021, the same team had 102 throws, scored 65 goals, and earned 130 points.

In 2019, the first-place team had a spinshot shot efficiency of 82.18% (SD = 10.53), while in 2021, the first-place team had an average efficiency of 72.95% (SD = 6.22). The second-place teams in both 2019 and 2021 had an efficiency of 87.5% (SD = 14.67) and 75.65% (SD = 4.27), respectively. The third-place teams had an efficiency of 92.1% (SD = 8.74) in 2019 and 72.86% (SD = 3.90) in 2021.

In 2019, the Romanian team had a spinshot shot efficiency of 37.60% (SD = 7.74), with a total of 38 throws and 14 goals, earning 28 points from spinshot throws. The average number of throws per game in 2019 was 6.33 (SD = 1.37), with an average of 2.33 goals (SD = 0.52). In the 2021 edition, the team had an efficiency of 56.94% (SD = 21.79) with a total of 102 throws at the goal and 65 goals from spinthrows. The average number of throws per game for the 2021 team was 7.37 (SD = 54.29), with an average of 9.29 goals (SD = 6.37).

In 2019, the first-place team had a total of 32 aerial throws at the goal, with 26 goals and 52 points. In 2021, the first-place team had 45 aerial throws, 18 goals, and 36 points. The second-place team in both 2019 and 2021 had 18 aerial throws with 13 goals and 26 points in 2019, and 36 aerial throws, 22 goals, and 44 points in 2021. The third-place team in 2019 had 17 aerial throws and 10 goals, earning 20 points, while in 2021, the same team had 14 aerial throws, 5 goals, and 10 points.

Table 2.
Statistical analysis regarding the efficiency of the points won

Teams		Year	N	Min.	Max.	Media	D. Standard	Variance
I	Ef.	2019	6	77.78	83.08	80.33	2.31	5.33
		2021	6	62.96	70.97	66.28	3.50	12.27
II	Ef.	2019	6	70.91	88.57	79.00	6.23	38.79
		2021	6	64.44	79.66	73.32	5.27	27.75
III	Ef.	2019	6	75.00	84.38	78.68	3.48	12.14
		2021	6	68.42	82.14	75.70	5.50	30.24
Ro	Ef.	2019	6	58.00	70.27	63.02	4.72	22.31
		2021	6	55.36	67.21	61.49	4.61	21.22

Notă: Ef. = Eficiență

In beach handball, 2-point goals can be crucial in a team's performance during a competition or for winning it. Table 12 shows a decrease in the efficiency of 2-point goals in the 2021 edition compared to 2019. This situation may indicate that in the competitive journey of these

4 teams, a higher number of attempts was allowed, followed by a decrease in the efficiency of finishing, but with a higher average of goals per match than in the 2019 edition.

Regarding the efficiency of 2-point goals, the team in 1st place had an efficiency percentage of 80.33% (SD = 2.31), and in 2021, an efficiency percentage of 66.28% (SD = 3.50). The teams in 2nd place at the end of both editions of the CE BH U17 had an efficiency percentage of 79% (SD = 6.23) in 2019, and in 2021, it was 73.32% (SD = 5.27). The teams finishing 3rd on the podium had an efficiency percentage of 76.68% (SD = 3.48) in 2019 and 75.70% (SD = 5.50) in 2021. The same situation is observed for the Romanian team – 63.02% (SD = 4.72) in 2019 and 61.49% (SD = 4.61) in 2021.

6.5 Discussions

Beach handball took a significant step toward solidifying its status as a sport discipline by being included as a sport in the Youth Olympic Games in 2018. Its main characteristic is its spectacular nature, with players choosing to finish attacks in various ways (goal from the goalkeeper's area to the opponent's area, aerial goal, or spinshot goal), actions that are worth 2 points when scoring a goal (Lara et al., 2018).

In the 2019 CE BH U17, the efficiency percentages were close for the teams on the podium: 1st place had an efficiency of 82.18%, 2nd place with 87.5%, and 3rd place with 92.1%. Even though 3rd place had a higher percentage, the difference was made in the number of attempts in which teams chose to complete their attacks. In 2021, the 1st-place team had an efficiency of 72.95%, the 2nd-place team had an efficiency of 75.65%, and the 3rd-place team had an efficiency of 72.86%.

In this context, we can observe the importance of improving the efficiency of shooting at the goal and the necessity of enhancing the technical procedure of shooting from a spinshot to achieve a higher position in the final rankings of a beach handball competition.

6.6 Conclusions

Based on the observation sheets created during the two editions of the CE BH U17 in 2019 and 2021, we observed a doubling in the total number of throws worth 2 points from 2019 to 2021, while the number of throws worth 1 point was four times lower than in 2019.

The two spectacular shooting techniques, spinshot and aerial, had a higher rate of utilization during the 2021 edition of CE BH U17 compared to the 2019 edition. The average

number of goals scored was higher per match. However, we can observe similar values of standard deviation for both total throws at the goal and goals scored, indicating a coherent strategy during the early stages of CE BH U17.

The efficiency of 1-point throws increased in the 2021 CE BH U17 edition compared to the 2019 edition. Still, the results show a decrease in these throws on goal during the games, as teams preferred to score goals using the techniques worth 2 points.

In conclusion, considering that shooting from a spinshot conditions athletic performance in beach handball, we believe that an analysis of the shooting technique from this technical procedure is necessary to bring improvements to its efficiency during a game.

SYNTHESIS CHAPTER 7. Study II – Comparative analysis of spinshot throws in beach handball

7.1 Research purpose

The purpose of this research was to conduct a comparative analysis of the spinshot shooting technique between an advanced player and a beginner player in order to obtain valuable information about a technical profile regarding spinshot shooting in beach handball and to guide training to improve the efficiency of this shooting technique.

7.2 Research objectives

- Analyzing video recordings of the performances of two athletes (beginner and advanced) in terms of the angles between body segments and between the body and the ground at different stages of the shooting technique.
- Analyzing the trajectory and rotation time (execution time) of the two athletes in performing the spinshot shooting technique.

7.3 Research organization

For the analysis of the throws, video recordings of the performances of two subjects, beach handball players, were made - one being an advanced player, and the other a beginner player. To measure the parameters to be analyzed, the angular characteristics of body segments at key moments of the spinshot shooting technique execution, and the execution times of the two athletes, the Kinovea software version 0.9.5 was used..

7.4 Results of the determinations of the specific spinshot throws movement parameters

The spinshot throws technique is very complex in terms of execution. Players must coordinate every step, every body segment to perform this technical procedure correctly and efficiently. Therefore, it is necessary to conduct a detailed analysis of the movements, highlighting the key moments of the executions.

Figure 1. The angle between the trunk and thigh before making the shot

The difference between the advanced player and the beginner in performing half (180º) of the spinshot shooting technique lies in the flight phase. In Figure 19, it can be observed that the advanced player has the necessary height to complete the procedure, with her legs pushing upwards, and her throwing arm is raised, ready to throw the ball. The beginner player completes the 180º rotation, but her legs lag behind, with her right foot still on the ground, and her throwing arm is not prepared for the finish. Equally important is the angle between the trunk and the thigh during the 180º rotation. The greater the angle, the more challenging it is to achieve a complete trunk rotation.

The anterior-posterior impulse and the pushing force are parameters that indicate the future position of the players towards the goal when performing the procedure, providing precise data on the flight direction and jump height.

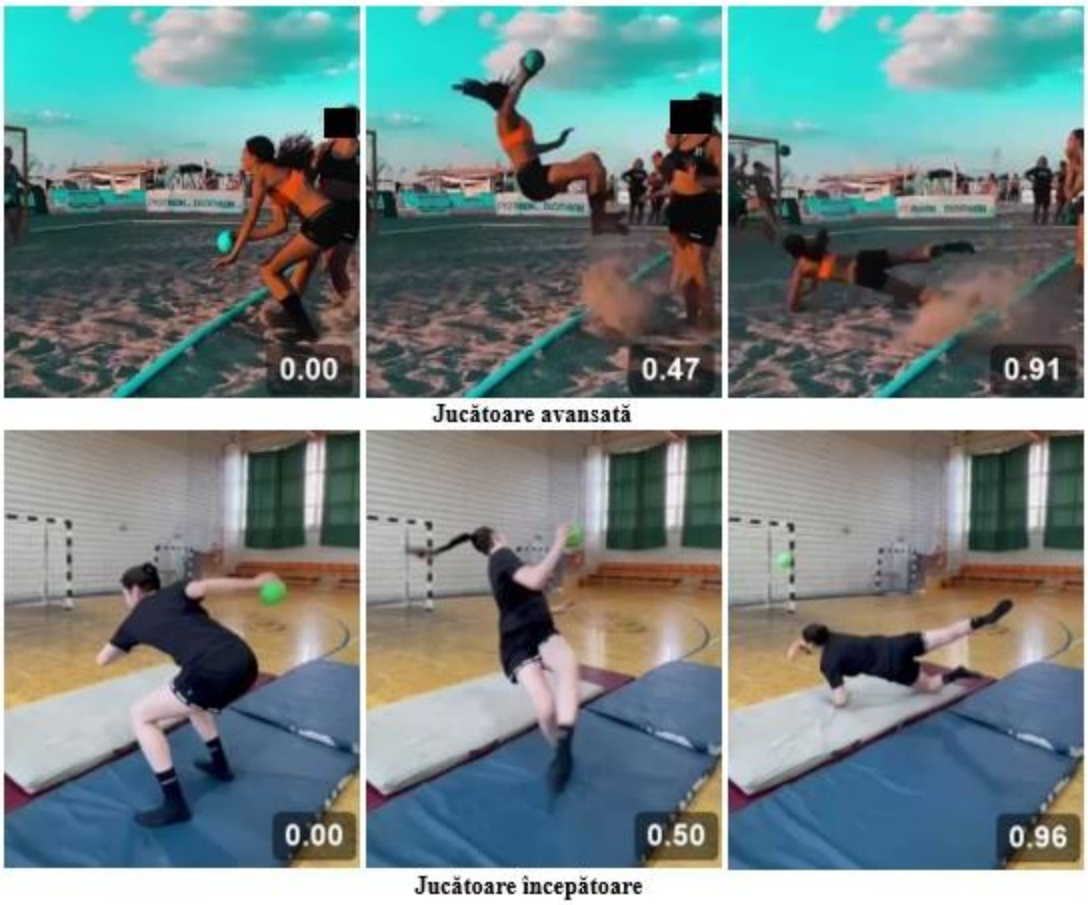


Figure 2. Time of execution

Execution time and force are important factors in performing the spinshot shooting technique in beach handball. In addition to mastering the correct technique, the speed of executing a technical finishing move is crucial in scoring and validating a goal. Every attacking tactic has an end goal, and the player in a position to score a goal must execute the shot as accurately and quickly as possible, regardless of the chosen technical procedure; otherwise, they can be caught off guard and blocked by a defender.

We can see in Figure 21 that the execution times are close between the two players, but through video analysis, we were able to observe the quality of their executions regarding the correct completion of the spinshot shooting.

7.5 Conclusions

This analysis has led to the identification of the muscles involved in executing the spinshot shooting, their manner of engagement, execution times, and the ground forces required for this action. The analysis results highlight significant differences in joint amplitude between the two players during spinshot shooting executions, which can be caused by insufficient strength of the muscle groups involved, inadequate joint mobility, or incorrect mastery of the shooting technique.

To improve the performance of beginner players and enhance their efficiency when shooting the ball into the goal with a spinshot, it is necessary to implement a well-structured training program. This program should focus on improving the execution technique, increasing ground forces, and, at the same time, preventing injuries caused by incorrect execution.

PART III

SYNTHESIS CHAPTER 8. Studiul III – The effect of ground reaction forces in performing spinthrows throws in beach handball

8.1 Research premises

Starting from the premise that improving the throwing technique can be achieved through various training methods, we aimed to analyze the effectiveness of the proposed means to achieve an enhancement of the finishing phase in the spinshot throw by female beach handball players aged 16-18.

Therefore, our premises assume that the use of training means and methods in the intervention program can lead to improvements in the efficiency of spinshot throws specific to beach handball for junior players..

8.2 Research purpose

The study is an applied research and development, aimed at the development and verification of the effect of an intervention program regarding the development of explosive lower limb strength in junior beach handball players. We intended to analyze the data obtained at the end of three mesocycles of training and formulate observations regarding the increase in ground forces and the improvement of efficiency in spinshot throws.

8.3 Research hypothesis

In this research, several hypotheses are proposed to analyze the impact of the intervention program on the ground forces generated by the research subjects at the end of each observed period – mesocycle 1, mesocycle 2, and mesocycle 3. The following hypotheses have been formulated:

1. The means of acquiring the technique of throwing at the goal used in mesocycle 1 alter the values of the main ground force indicators.
2. The use of plyometric methods in the intervention program in mesocycle II of training leads to a modification of ground forces.
3. The training methods used during the competitive period (mesocycle III) influence the ground forces generated.

8.4 Research objectives

The personal contribution study regarding the improvement of the spinning shot technique in beach handball aims to achieve the following objectives:

- Implementation of the intervention program within the annual training plan for junior players.
- Initial testing of the subjects.
- Implementation of the intervention program.
- Final testing of the subjects.
- Statistical analysis of the data.

8.5 Research subjects

The research involved female athletes, handball players affiliated with the "Viitorul" Sports School Club in Cluj-Napoca. The working sample consisted of 13 athletes aged between 16 and 18 years (16.78 ± 0.8 years) with an average height of 175.28 ± 5.53 cm.

The selection of the athletes took into account their specific characteristics such as age, morpho-functional characteristics, and motor capacity. The athletes provided written consent to participate in the research (see Appendix 3).

8.6 The intervention program within the research

The specific beach handball training sessions took place in the sports hall of "Avram Iancu" Theoretical High School in Cluj-Napoca and in the "Dr. Iuliu Hatieganu" Sports Park. These training sessions were held three times a week (Monday, Wednesday, and Friday), each lasting 90 minutes.

The proposed intervention program was integrated into the annual training plan of the handball players. It was divided into three distinct periods, each covering specific objectives related to the respective mesocycles:

1. Mesocycle I - January 3, 2021, to May 31, 2021: This mesocycle focused on technical preparation for the spinshot goal shooting through a variety of specific exercises.
2. Mesocycle II - June 5, 2021, to August 28, 2021: In this mesocycle, physical preparation of the athletes was the main objective, with a focus on improving physical qualities, particularly explosiveness.

3. Mesocycle III - August 30, 2021, to September 15, 2021: During this mesocycle, the goal was to monitor the team's and players' performance throughout the competition.

8.7 Description of the measurement tools used in the research

Evaluating the level of explosive strength:

To assess the force couple and technique, the AMTI NETforce platform, model BP400600, was used, providing high precision. It is made of aluminum, weighs 31.82 kg, and has dimensions of 400x600x82.55 mm.

Figure 3. Force platform AMTI (amti.biz, 2020)

The platform provides several tools for force analysis and algorithms to calculate variables such as the center of pressure, standard deviations, radial measurements, and balance parameters. Among these, we used software called BioAnalysis.

Out of all the variables that the analysis program offers, we focused on the following:

- Radial Displacement: It represents the deviation of the center of pressure position during execution from the initial (contact) position.
- Force: It measures the interaction between two bodies and its effect. We monitored two aspects of force: maximum force (FM) and minimum force (Fm).
- Mechanical Work: It represents the amount of energy used to produce a change in the dynamic state of a system. We tracked two aspects of mechanical work: maximum mechanical work (LM) and minimum mechanical work (Lm).

- Power (P) (Lm/s): It represents the amount of energy converted or used per unit of time. Power is the rate of change of energy (W) with respect to time. We monitored two aspects of power: maximum power (PM) and minimum power (Pm).
- Impulse: It represents the amount of effort exerted for changing the state of motion. We tracked two aspects of impulse: vertical impulse (Iv) and anterior-posterior impulse (Iap).
- Force Couple (CF): It represents a system consisting of two equal forces located on the same plane.
- Execution Time (Te): It represents the time required for the execution of processing an algorithm.

The protocol for using the AMTI Net Force platform in research consisted of the following steps:

1. Each subject had 10 minutes to warm up before stepping onto the platform. The warm-up focused on selectively affecting the musculoskeletal system, with an emphasis on the lower body.
2. Execution of one of the three jumps/throws: a simple vertical jump with a landing on the ground, a jump with a spinshot without an approach, a jump with a spinshot with an approach and with the beach handball in hand.
3. After the test, the subjects performed stretching exercises.

The three measured jump/throw variations within the protocol were as follows:

1. Jump 1 (S1) - The subject had to perform a vertical jump with a landing on the ground. The goal was to familiarize the subject with the apparatus and the landing.
2. Jump 2 (S2) - The subject had to perform the beach handball throw with a spin, hitting the platform, with a landing on the ground. The goal was to isolate the take-off part of the actual spinshot.
3. Jump 3 (S3) - The subject had to execute the complete beach handball throw with a spin, including an approach, and holding the ball in hand, with a landing on the ground. The goal was to measure the complete execution of the beach handball throw with a spin.

8.8 Statistical analysis

All statistical analyses were performed using the SPSS Statistics software (version 17; SPSS, Inc., Chicago, IL) with a significance level of 5% (significance accepted when $p < .05$). Data distribution was checked using the Shapiro-Wilk test, and means were compared using distribution-dependent tests.

8.9 Results

Following the collection and processing of data obtained from the measurements, the results were presented based on the analyzed mesocycle, the measurement moments (T1, T2, T3, T4), and the type of jump analyzed – without momentum (S2) or with momentum (S3). Additionally, the results were presented based on the analyzed variables. To compare the means at the two measurement moments in each mesocycle, a paired t-test was used because the data were normally distributed ($p > .05$).

8.9.1 The results obtained at the end of mesocycle I are as follows:

Table 3.
Comparison of means fot the variables DR, Te, Iv, Iap, CF and S2 (mesocycle 1) is as follows:

Variables	U.M.	Media	N	D.Standard	Test Shapiro-Wilk	t	df	Sig. (2-tailed)	Mărimea Efectului (Cohen's d)
S2_DR_T1	r	2.96	13	1.28	0.17	0.40	12	0.70	0.11
S2_DR_T2	r	3.20	13	1.54	0.11				
S2_Te_T1	s	1.16	13	0.31	0.54	2.35	12	0.01	0.86
S2_Te_T2	s	1.19	13	0.19	0.81				
S2_Iv_T1	N*s	961.65	13	210.97	0.65	0.57	12	0.58	0.16
S2_Iv_T2	N*s	1003.66	13	121.01	0.44				
S2_Iap_T1	N*s	22.63	13	29.59	0.28	-2.72	12	0.05	-0.48
S2_Iap_T2	N*s	16.68	13	8.09	0.14				
S2_CF_T1	(10^{-2})*N*m	1696.57	13	554.83	0.42	2.91	12	0.01	0.81
S2_CF_T2	(10^{-2})*N*m	2770.50	13	1323.43	0.77				

Notă: S2 = Săritură cu piruetă de pe loc; DR = Deplasare radială;Te= Timpul de execuție;
Iv = Impulsul pe verticală; Iap = Impulsul anterior-posterior; CF = Cuplul de forțe; T1 = Testarea 1; T2 =Testarea 2;
r = radiani; s = secunde; N*s = Newton/secundă

A paired t-test was conducted to:

- compare DR values for S2 before (S2_DR_T1) and at the end of mesocycle I (S2_DR_T2) in Table 22. No statistically significant difference was found between S2_DR_T1 (M= 2.96; SD= 1.28) and S2_DR_T2 (M= 3.20; SD= 1.54); t= 0.40, p= 0.70, d= 0.11.
- compare Te values for S2 before (S2_Te_T1) and at the end of mesocycle I (S2_Te_T2) in Table 22. A statistically significant difference was found between S2_Te_T1 (M= 1.16; SD= 0.31) and S2_Te_T2 (M= 1.19; SD= 0.19); t= 2.35, p= 0.01, d= 0.86.
- compare Iv values for S2 before (S2_Iv_T1) and at the end of mesocycle I (S2_Iv_T2) in Table 22. No statistically significant difference was found between S2_Iv_T1 (M= 961.65; SD= 210.97) and S2_Iv_T2 (M= 1003.66; SD= 121.01); t= 0.57, p= 0.58, d= 0.16.
- compare Iap values for S2 before (S2_Iap_T1) and at the end of mesocycle I (S2_Iap_T2) in Table 22. A statistically significant difference was found between S2_Iap_T1 (M= 22.63; SD= 29.59) and S2_Iap_T2 (M= 16.68; SD= 8.09); t= -2.72, p= 0.05, d= -0.48.
- compare CF values for S2 before (S2_CF_T1) and at the end of mesocycle I (S2_CF_T2) in Table 22. A statistically significant difference was found between S2_CF_T1 (M= 1696.57; SD= 554.83) and S2_CF_T2 (M= 2770.50; SD= 1323.43); t= 2.91, p= 0.01, d= 0.81.

8.9.2. The results obtained at the end of mesocycle II are as follows

Table 4.
Comparison of means for the variables DR, Te, Iv, Iap, CF, for S2 (mesocycle 2)

Variables	U.M.	Media	N	D. Standard	Test Shapiro-Wilk	t	df	Sig. (2-tailed)	Mărimea Efectului (Cohen's d)
S2_DR_T2	r	3.20	13	1.54	0.11	0.49	12	0.63	0.14
S2_DR_T3	r	3.56	13	1.41	0.80				
S2_Te_T2	s	1.19	13	0.19	0.81	-1.26	12	0.23	-0.35
S2_Te_T3	s	1.12	13	0.21	0.44				
S2_Iv_T2	N*s	1003.66	13	121.01	0.44	-3.14	12	0.01	-0.87
S2_Iv_T3	N*s	866.41	13	164.96	0.32				
S2_Iap_T2	N*s	16.68	13	8.09	0.14	-0.08	12	0.94	-0.02
S2_Iap_T3	N*s	14.72	13	15.22	0.13				
S2_CF_T2	(10^{-2})*N*m	2770.50	13	1323.43	0.77	0.24	12	0.82	0.07

S2_CF_T3	(10^{-2})*N*m	2582.34	13	1215.84	0.42

Notă: S2 = Săritură cu piruetă de pe loc; DR = Deplasare radială;Te= Timpul de execuție;
Iv = Impulsul pe verticală; Iap = Impulsul anterior-posterior; CF = Cuplul de forțe; T1 = Testarea 1; T2 =Testarea 2;
r = radiani; s = secunde; N*s = Newton/secundă;

A paired t-test was conducted to:

- compare DR values for S2 before (S2_DR_T2) and at the end of mesocycle II (S2_DR_T3) in Table 26. No statistically significant difference was found between S2_DR_T2 (M= 3.20; SD= 1.54) and S2_DR_T3 (M= 3.56; SD= 1.41); t= 0.49, p= 0.63, d= 0.14.
- compare Te values for S2 before (S2_Te_T2) and at the end of mesocycle II (S2_Te_T3) in Table 26. No statistically significant difference was found between S2_Te_T2 (M= 1.19; SD= 0.19) and S2_Te_T3 (M= 1.12; SD= 0.21); t= -1.26, p= 0.35, d= -0.35.
- compare Iv values for S2 before (S2_Iv_T2) and at the end of mesocycle II (S2_Iv_T3) in Table 26. A statistically significant difference was found between S2_Iv_T2 (M= 1003.66; SD= 121.01) and S2_Iv_T3 (M= 866.41; SD= 164.96); t= -3.14, p= 0.01, d= -0.87.
- compare Iap values for S2 before (S2_Iap_T2) and at the end of mesocycle II (S2_Iap_T3) in Table 26. No statistically significant difference was found between S2_Iap_T2 (M= 16.68; SD= 8.09) and S2_Iap_T3 (M= 14.72; SD= 15.22); t= -0.08, p= 0.94, d= -0.02.
- compare CF values for S2 before (S2_CF_T2) and at the end of mesocycle II (S2_CF_T3) in Table 26. No statistically significant difference was found between S2_CF_T2 (M= 2770.50; SD= 1323.43) and S2_CF_T3 (M= 2582.34; SD= 1215.84); t= 0.24, p= 0.82, d= 0.07.

8.9.3 The results obtained at the end of mesocycle III are as follows

Table 5.
Comparison of means for the variables DR, Te, Iv, Iap, CF, pentru S2 (mezociclul 3)

Variabile	U.M.	Media	N	Ab. Standard	Test Shapiro-Wilk	t	df	Sig. (2-tailed)	Mărimea Efectului (Cohen's d)
S2_DR_T3	r	3.56	13	1.41	0.80	-0.03	12	0.98	-0.01
S2_DR_T4	r	3.55	13	0.88	0.99				
S2_Te_T3	s	1.12	13	0.21	0.44	0.50	12	0.63	0.14
S2_Te_T4	s	1.16	13	0.17	0.85				
S2_Iv_T3	N*s	866.41	13	164.96	0.32	0.84	12	0.42	0.23

S2_Iv_T4	N*s	923.79	13	166.54	0.95				
S2_Iap_T3	N*s	14.72	13	15.22	0.13	-0.42	12	0.68	-0.12
S2_Iap_T4	N*s	14.29	13	9.39	0.19				
S2_CF_T3	(10^{-2})*N*m	2582.34	13	1215.84	0.42	-0.34	12	0.74	-0.10
S2_CF_T4	(10^{-2})*N*m	2679.20	13	1386.48	0.13				

Notă: S2 = Săritura cu piruetă de pe loc; DR = Deplasare radială;Te= Timpul de execuție;
Iv = Impulsul pe verticală; Iap = Impulsul anterior-posterior; CF = Cuplul de forțe; T3 =Testarea 3; T4 =Testarea 4; r = radiani; s = secunde; N*s = Newton/secundă

A paired t-test was conducted to:

- compare DR values for S2 before (S2_DR_T3) and at the end of mesocycle III (S2_DR_T4) in Table 30. No statistically significant difference was found between S2_DR_T3 (M= 3.56; SD= 1.41) and S2_DR_T4 (M= 3.55; SD= 0.88); t= -0.03, p= 0.98, d= -0.01.
- compare Te values for S2 before (S2_Te_T3) and at the end of mesocycle III (S2_Te_T4) in Table 30. No statistically significant difference was found between S2_Te_T3 (M= 1.12; SD= 0.21) and S2_Te_T4 (M= 1.16; SD= 0.17); t= -0.50, p= 0.63, d= 0.14.
- compare Iv values for S2 before (S2_Iv_T3) and at the end of mesocycle III (S2_Iv_T4) in Table 30. No statistically significant difference was found between S2_Iv_T3 (M= 866.41; SD= 164.96) and S2_Iv_T4 (M= 923.79; SD= 166.54); t= 0.84, p= 0.42, d= 0.23.
- compare Iap values for S2 before (S2_Iap_T3) and at the end of mesocycle III (S2_Iap_T4) in Table 30. No statistically significant difference was found between S2_Iap_T3 (M= 14.72; SD= 15.22) and S2_Iap_T4 (M= 14.29; SD= 9.39); t= -0.42, p= 0.68, d= -0.12.
- compare CF values for S2 before (S2_CF_T3) and at the end of mesocycle III (S2_CF_T4) in Table 30. No statistically significant difference was found between S2_CF_T3 (M= 2582.34; SD= 1215.84) and S2_CF_T4 (M= 2679.20; SD= 1386.48); t= -0.34, p= 0.74, d= -0.10.

8.10 Discussions

8.10.1 Discussions based on the results obtained in Mesocycle I

The results obtained in Mesocycle I showed statistically significant differences for the parameters of executing the technical procedure without momentum (S2), Iap (p=0.05), CF (p=0.01), and Te (p=0.01). Regarding the execution of the complete technical procedure with

momentum (S3), statistically significant differences were found in the parameters Te (p=0.01), Iv (p=0.03), and CF (p=0.01).

In this initial stage of the research, the focus was on improving the technique of the spinshot throw in beach handball for the players through various means and methods implemented in their training.

8.10.2 Discussions based on the results obtained in Mesocycle II

The results obtained in Mesocycle II showed statistically significant differences for the parameters of executing the technical procedure without momentum (S2), Iv (p=0.05), Fa (p=0.05), La (p=0.00), and Pa (p=0.01). Regarding the execution of the complete technical procedure with momentum (S3), statistically significant differences were found in the parameters La (p=0.00), Pi (p=0.03), and Pa (p=0.03).

During this mesocycle, focused on general physical preparation, we utilized plyometric exercises (see Annex 1) to increase explosive strength. Previous research in the literature has highlighted the positive effects of these methods in athlete training (Markovici, 2007; Asadi et al., 2012; Saez de Villareal et al., 2013).

8.10.3 Discussions based on the results obtained in Mesocycle III

The results obtained in Mesocycle III showed statistically significant differences for the parameters of executing the technical procedure without momentum (S2), Fa (p=0.05), La (p=0.00), and Pa (p=0.01). For the execution of the technical procedure with momentum (S3), statistically significant differences were found in the parameters La (p=0.00), Pi (p=0.03), and Pa (p=0.03).

During this mesocycle, the athletes maintained their competitive form, engaging in preparation matches and participating in the National Beach Handball Championship for junior players.

All the mentioned parameters, including shock force, shock mechanical work, push power, and shock power, showed statistically significant increases for both jump types, S2 and S3, from one measurement (T3) to another (T4) at the end of Mesocycle III.

8.11 Conclusions

Based on the results obtained in the conducted research, the following conclusions can be drawn:

1. Following the analysis of the results from the measurements conducted during Mesocycle I, it confirms Research Hypothesis 1. The selection of exercises from the training program contributes to the improvement of the spinshot shot technique at the goal, supported by the increased values in the final measurements of variables: anterior-posterior impulse, vertical impulse, force couple, mechanical work during pushing, and execution time.
2. The results recorded at the end of Mesocycle II indicate changes in variables such as strength, vertical impulse, shock force, push power, and shock power in the research subjects, revealing a decrease in their values. However, there were no changes in variables such as radial displacement, execution time, anterior-posterior impulse, and force couple. Therefore, Research Hypothesis 2 is partially confirmed.
3. The levels of the measured parameters at the end of Mesocycle III highlighted differences in the execution of the technical procedure for the two jumps, with or without momentum. The increase in average values for strength parameters, such as shock force, push power, and shock power, showed the correct and efficient mastering of the technical procedure for a spinshot shot with momentum (S3). This indicates that the subjects can execute the technical procedure easily in game conditions (holistically) rather than analytically (as in the case of S2). Thus, Research Hypothesis 3 is confirmed.

SYNTHESIS Chapter 9. Study IV – Statistical analysis of the distribution and efficiency of goal throws in teams participating in the 2021 National Beach Handball Championship

9.1 Research purpose

The purpose of this research was to investigate the technical throwing methods used by participating teams and their efficiency in the 2021 National Beach Handball Championship. In addition to this aspect, we also aimed to observe the performance of the CSS Viitorul Cluj team in terms of goal scoring during friendly matches in 2020 compared to their performance in the National Championships in 2021..

9.2 Research objectives

- Analyzing the proportion and efficiency of throws for each team that placed on the podium at the 2021 National Junior Beach Handball Championship.
- Identifying the performance level of the CSS Viitorul Cluj team at the 2021 National Beach Handball Championship and comparing it to their performance at the friendly beach handball competition in 2020.

9.3 Research organization

Throughout the 2021 National Junior Beach Handball Championship and the friendly competition held in 2020, observation sheets were completed, containing data on the number of all throwing procedures (throws and goals) (Study I).

9.4 Results

The percentage and efficiency of goal throws, as well as the number of goals scored, were statistically analyzed based on the averages obtained for each match. The percentage indicates how many throws each team had and how many goals were scored, while efficiency shows how many points were earned from the total number of throws made by each team.

According to Table 34, the CSS Viitorul Cluj-Napoca team, which included the subjects of our study, had a total of 148 two-point goal throws at the 2021 National Championship, compared to the teams placed second and third (112 and 117 goal throws, respectively). The

number of goals scored was significantly higher for CSS Viitorul, with 138 goals, compared to 69 for CS Ghimbav and 89 for CSS Constanța. As a result, the number of points obtained by the team from Cluj is much higher. This shows that the efficiency of two-point goal throws was better for CSS Viitorul, even though the team had one match less than the other teams.

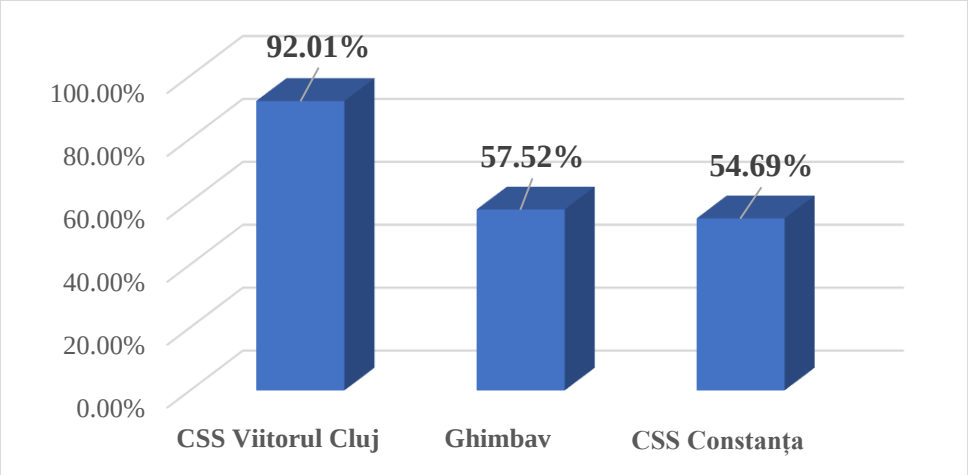
Table 6.
The number of throws and goals scored by the teams included in the study

Year	Teams	N	Total throws		Spinthrows throws		2 points throws		1 point throw	
			Sh.	Gol.	Sh.	Gol.	Sh.	Gol.	Sh.	Gol.
2020	CSS Viitorul Cluj	7	173	158	114	97	48	35	11	9
2021	CSS Viitorul Cluj (I)	6	161	150	125	115	23	23	13	12
	CS Ghimbav (II)	7	203	148	45	26	67	43	91	79
	CSS Constanța (III)	7	176	139	24	12	93	77	59	50

Table 7.
Statistical analysis of data fot the spinshot throw by the teams ranked in the top 3 positions at the National Beach Handball Championship in 2021

Variable	Year	N	Min.	Max.	Media	Standard Deviation	Variance
I_Pir_%	2021	6	82.35	100.00	92.01	6.13	37.63
I_Pir_Ar	2021	6	17.00	26.00	20.83	3.25	10.56
I_Pir_G	2021	6	14.00	23.00	19.16	3.06	9.36
II_Pir_%	2021	7	50.00	62.50	57.52	4.29	18.39
II_Pir_Ar	2021	7	6.00	45.00	12.86	14.21	201.81
II_Pir_G	2021	7	3.00	26.00	7.43	8.22	67.62
III_Pir_%	2021	7	40.00	100.00	54.69	20.40	416.12
III_Pir_Ar	2021	7	2.00	24.00	6.86	7.84	61.48
III_Pir_G	2021	7	1.00	12.00	3.43	3.87	14.95

Notă: Pir = Piruetă; Ar = Aruncare; % = Procentaj, G = gol.



Graph 1. The use of spinshot throws at the National Beach Handball Championhip in 2021 by the analyzed teams

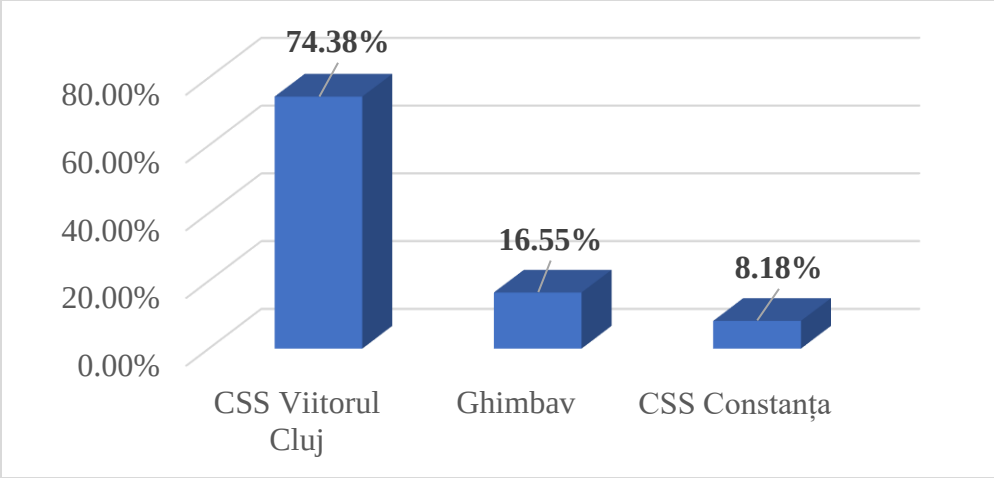
The team that finished in first place at the National Beach Handball Championship for Juniors I in 2021, CSS Viitorul Cluj, had a shooting efficiency of 92.01% (SD=5.60) with a total of 125 throws at the goal and 115 goals scored, resulting in 230 points (Graphs 1 and 2). The team in second place, CS Ghimbav, had a shooting efficiency of 57.52% (SD=4.29) with a total of 45 throws at the goal and 26 goals scored, resulting in 52 points. CSS Constanța, the team in third place, had a shooting efficiency of 54.69% (SD=20.40) with a total of 24 throws at the goal and 12 goals scored, resulting in 24 points (Table 35).

Table 8.
Statistical analysis of the efficiency of points won from spisnthrows by the teams ranked in the top 3 positions at the National Beach Handball Championship in 2021

Team	Year	N	Min.	Max.	Media	Standard Deviation	Variance
I_Ef_Pir	2021	6	63.64	83.33	74.38	7.23	52.25
II_Ef_Pir	2021	7	12.50	20.41	16.55	2.89	8.38
III_Ef_Pir	2021	7	4.08	11.11	8.18	2.89	8.37

Notă: Ef = Eficiența; Pir = piruetă

The team CSS Viitorul Cluj (I) had an efficiency of points won from spinshot throws of 74.38% (SD=7.23), while the CS Ghimbav team had an efficiency of 16.55% (SD=2.89), and the CSS Constanța team had an efficiency of 8.18% (SD=2.89) from the same technical procedure of spinshot throws (Table 38).



Graphic 2. The efficiency of points won from spinshot throws at the CNBH 2021

From the obtained data, we can observe that the efficiency of spinshot throws at the goal for the CSS Viitorul Cluj team is higher compared to the teams placed second and third. The attacking actions of the first-place team are particularly characterized by successful spinshot throws at the goal.

9.5 Discussions

In the specialized literature, the topic of goal throws and their efficiency in beach handball is up-to-date, with numerous recent analyses conducted at major competitions.

The difference between winning and losing teams lies in how each team or player chooses to finish their attack. In beach handball, the spinshot throw at the goal is rewarded with 2 points when scoring a goal. Morillo (2009) points out that as spectacular as this technical procedure of goal throwing is, it is equally important during a match.

Regarding the use of goal-throwing techniques by the top 3 teams during the 2021 National Beach Handball Championship, the situations encountered varied. The CSS Viitorul Cluj team had the most attacking actions completed through spinshot throws at the goal, with a success rate of 92.01%. The other teams, ranked 2nd and 3rd, primarily focused on scoring goals by the specialist player (simple throws but worth 2 points), as well as 1-point goal throws (classic throws in handball).

9.6 Conclusions

Through the analysis of the data obtained after the 2021 National Beach Handball Championship for women juniors I, we could observe a different approach by the teams ranking 1st to 3rd regarding the completion of each attack in the matches played.

The CSS Viitorul Cluj team had a percentage of 92.01% for spinshot throws at the goal, compared to CS Ghimbav (57.52%) and CSS Constanța (54.69%). Considering this aspect, according to Study I in Part III of the work, the CSS Viitorul Cluj team adopted an attacking model focused on spinshot goal throws, a factor that conditions athletic performance in beach handball, with an efficiency rate of 74.38% in this technique.

In conclusion, we believe that the CSS Viitorul Cluj team, following the program implemented within the annual training plan, improved the efficiency of their spinshot goal throws, which led to sporting success by winning the 2021 National Beach Handball Championship for women juniors I.

Chapter 10. The conclusions of the Doctoral Thesis

The data collected from the specialized literature has helped us outline the current trends in beach handball, as described by experts, both qualitatively and quantitatively, thus allowing us to create the appropriate context for starting new research.

The high level of performance achieved by the representative teams of other countries at the European Beach Handball Championships in 2019 and 2021, along with the low performance of the Romanian U17 team, obliges Romanian athletes and specialists to undertake suitable training, in line with the requirements of sports training, to achieve sporting excellence. This also necessitates a review of the approach to beach handball, especially in terms of attack finalizations and the way they are carried out.

By analyzing the spin shot using video analysis software Kinovea, we have described the movements, segments, and muscle groups involved, providing important insights into how a spin shot should be executed. This can help prevent injuries resulting from incorrect execution and make improvements where needed.

The three training mesocycles aimed primarily to improve the execution of the technical spin shot, each with specific objectives (improving technique in mesocycle 1, modifying explosive strength variables in mesocycle 2, and maintaining physical fitness in mesocycle 3). The chosen training methods and exercises improved the technique of the beach handball players' spin shot and their ground-based strength. However, the plyometric training used in mesocycle 2 did not result in improved explosive strength.

The data from participation in friendly (2020) and official competitions of the CSS Viitorul Cluj team highlighted its unique playing style, emphasizing the preference for finalizing attacks with spin shots, which can be a determining factor in winning matches and competitions.

The limitations of the research and original contributions

Participation in beach handball competitions for women juniors I provided us with the opportunity to assess the effectiveness of the intervention program, its impact on spin shot technique, and its influence on ground reaction forces developed by the research subjects.

We acknowledge several limitations in this research, including:

1. The absence of a control group, which could have provided comparative data for the subjects in this study concerning improvements in ground reaction forces and the efficiency of spin shots in women juniors I' beach handball competitions.
2. The relatively small number of subjects included in the research.
3. The short duration of the intervention program.

The originality of this work lies in the fact that, to the best of our knowledge, it represents the first analysis of spin shots in beach handball in our country, particularly those rewarded with 2 points, as well as their efficiency.

Another aspect of the research's originality, in our opinion, is the development and application of a training program to teach and enhance spin shots for beach handball players. Additionally, the utilization of the AMTI force platform provided data about each jump performed (with or without a run-up), highlighting the shortcomings observed in each of the study participants. These aspects have, in our view, contributed to the development of ground reaction forces in our research subjects.

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