MINISTRY OF EDUCATION AND RESEARCH
UNIVERSITY „BABEȘ-BOLYAI" CLUJ NAPOCA
FACULTY OF PHYSICAL EDUCATION AND SPORT
DOCTORAL SCHOOL OF PHYSICAL EDUCATION AND SPORT

RESUME OF THE THESIS

OPTIMISATION OF THE HIT WITH THE BAT IN THE OINA GAME THROUGH BIOMECHANIC ANALYSIS

Phd. supervisor:
Prof. Univ. Dr. Gheorghe MONEA

Doctoral Student:
Cristian VĂDUVA

2020

Gratitude Notes

I would like to express my gratitude towards all the persons who helped me elaborating my PhD thesis.

I thank PhD. Gheorghe Monea for his trust, for his patience and generosity to share with me some of his experience.

I would like to give my thanks to the Dean of Faculty of Physical Education and Sport, PhD. Leon Gomboș, to the Head of Doctoral School of Faculty of Physical Education and Sport, PhD. Emilia-Florina Grosu and PhD. Iacob Hanțiu who were part of the Commission of Guidance, for the advice they gave me for through writing this study.

I would also like to thank PhD. Ligia Rusu and her research team from the Innovative Processes and Techniques in Bioenginery Laboratory from the Infrastructure of Applied Sciences and Research INCESA of the University of Craiova, for the help they provided.

I would like to express my respect towards Mr. Nicolae Dobre, the president of the Romanian Oina Federation, for his complete trust in me and to all persons who promote and love this national sport.

Last but not least, I would like to express my gratitude towards my family for the moral support throughout this period and without whom I could not have written my thesis.

Cristian Văduva

KEYWORDS : oina, bat, parameters, biomechanics, training

DISSEMINATION OF RESULTS

The Results of this research were disseminated through attending to different scientific manifestations. I have also published articles in scientific journals as following:

Rusu, L., Marin, M., **Văduva, C**., Dragomir, M. (2018). *Clinical and biomechanic considerations of insfraspinatus syndrome at athletes Congress F.S.P.A. Helsinki.*

Rusu, L., Marin, M., **Văduva, C**., Dragomir, M. (2018). *Biomechanic assessment of shoulder stability in specific oina sport activity Congress F.S.P.A. Helsinki* accepted for a poster presentation at our congress Prevention.

Văduva, C., Monea, Ghe., Marin, M., Rusu, L. (2019). Analysis of stick shoting in oina game using the biomechanics parameters *International Proceedings of Human Motricity/ ICPESK 2019 Supplementary Issue of Discobolul – Physical Education, Sport and Kinetotherapy Journal p. 331-338*, https://doi.org/10.35189/iphm.icpesk.2019.50

Marin, M., **Văduva, C**., Rusu, M., Rusu, L. (2019). Experimental determination the coefficient of restitution *International Conference on Innovative Research Euroinvent European Exhibition of Creativity and Innovation* https://iopscience.iop.org/article /10.1088/1757-899X/572/1/012103.

Văduva C., Monea Ghe., Marin M., Rusu L., (2020). The importance of the tasks of oina players when hitting the ball with a bat has been accepted for publication in issue2/2020 of the series IX *"Sciences of Human Kinetics" in the Bulletin of the Transilvania* University of Brașov.

Văduva, C., Marin, M., Rusu, L. (2020). Biomechanic parameters analysis of trunk in oina game - has been accepted for publication in Medicina Sportiva - *Journal of the Romanian Sports Medicine Society*, issue of June, 2020.

Văduva, C., Gheorghiu G.E. (2019). *Oina în 6* Editura Maya Publishing ISBN 978-607-618-709-1.

CONTENTS OF THE ABSTRACT OF THE DOCTORAL THESIS

List of abreviations

CR- The coefficient of return
CRH_F1000= The coefficient of return,determined from the measurement of the height of lift and fall, when cilliding with a beech cane from the height of 1000mm.
CRV_F1000= The coefficient of return,determined from the measurement of speeds after collision and before the with a beech cane from the height of 1000mm
CRH_F1400= The coefficient of return,determined from the measurement of the height of lift and fall, on a beech cane from the height of 1400mm.
CRH_S1400= The coefficient of return,determined from the measurement of the height of lift and fall,on a stick of salcâm from the height of 1400mm.
H- height
M- ball
S- subject

List of tabels

List of graphs

List of figures

CONTENTS OF THE DOCTORAL THESIS

PART I
THEORETICAL AND PRACTICAL FUNDAMENTS OF THE OINA GAME

INTRODUCTION

Oina is not just a game, it is a reason for pride, being the only national sport which is a part of our cultural heritage alongside with “doina” and other traditions. Buiac (2018) stated that oina “turned from a children’s game into a national Romanian sport” (p.83). We must add that minister SpiruHaret understood that once oina was introduced in the school curricula, these institutions would become the seed plot for great players who would later develop and promote our traditional sport.

Postolache (1969) stated that “from long forgotten times until the present, Romanians have loved to play oina. There fore this game was played with joy and happiness by generation after generation” (p.213).

But like any other sport, oina has been the subject of change, having its ups and downs in each time, gaining in dynamism by playing it in six players and also in spectacularity by playing it in 8 players, on the beach and starting with 2013 by women players.

Being a dynamic game, oina helps players develop a beautiful and healthy body, they also learn to work in teams, and since it is played in 11 players, it helps developing social skills on and outside the field. At the same time, players can learn to master their emotions, to want to become better, ambitious and competitive in order to reach their goal, and last but not least, oina helps forming the Romanian identity and tradition because “All that is Romanian must not die”.

CHAPTER I

MOTIVATION OF CHOOSING THE THEME

1.1. Motivation of choosing the theme

During an oina game we have noticed that the way a player hits the ball can make the difference in winning or loosing the game. The oina game is in a continuous evolution and there is a slight difference between the teams who fight for the first places, in a way that all players are very well prepared. By comparing the results of those teams when players play on catch positions, we have noticed that the results are pretty much the same and that trainers use the same techniques based on knowing their adversaries which makes the players realize a doubling and a recovery of the ball. This puts the adversary in difficulty and makes the players gain as many points as possible.

The difference between the way two teams play can be noticed when players must hit the ball with a bat. This led to a biomechanical analysis of the hitting with a ball through measuring the mechanical parameters of the movement and the temporal variations of the angles created between different segments of the body (shoulders, trunk, hips, elbow and knee), the variation of speed, force and of acceleration of the bat and also the player's anxiety when offering and hitting the ball.

1.2. The importance of the theme in sport literature

In the Romanian sport literature there are no studies to help us understand the importance of hitting with a ball biomechanically speaking. This research is necessary for further studies which can help trainers and other specialists to develop other ways for improving the hit of the oina ball with a bat.

1.3. The purpose of the research

The purpose of this research is to describe in detail the hit with the bat in an oina game through a biomechanical analysis, in order to get the necessary information to improve the shoot with a bat, which may lead to an advantage over the other team. Later on trainers can analyse the changes in the mechanics of hitting with the bat through the change of the speed of the execution.

1.4. The objectives of the research

- To study the hits of the oina bat from a biomechanical point of view through measuring the mechanical parameters of the movement, analysing the temporal variations of the angles which are created among the different segments of the body (shoulders, hip, elbow and knee), the variation of speed, force and acceleration of oina bat and also the co-player's anxiety when offering the ball in an oina game;
- To evaluate the trajectory of the ball based on lab results measured in the lab and of mechanical characteristics of the materials used;
- To determine the movement scheme of the upper limbs when hitting with the bat;
- To estimate the kinematic parameters involved when hitting with the bat;
- To improve the hit with the bat, to analyse and compare the hits based on the kinematic values of the bat linked to the values of speed and acceleration of the torsion angle;
- To develop different techniques when training players, based on the analysed parameters. This technique helps trainers improve their players' abilities because it uses new means and methods.

CHAPTER II
THE OINA GAME

2.1 Introduction in oina game

We have noticed that the oina game has gained in dynamism and evolved in spectacularity creating a new game conception. All these must be improved through research, studies or measurements which can establish the best angles to hit the ball with an oina bat, the time reaction of the defender and of the hitter.

2.2 Short history of the oina game

Why oina? Because oina was among the first sports included in the school curricula, next to the gymnastics, at the end of the XIX century. As SpiruHaret stated "Oina can bring a new life in the Romanian school, being a lovely sport and a true national Romanian sport".

A definition of oina was given to us by Buiac&Beleu (2005), in their book Oina - the perfect game: "a team game, which means no more than a free human activity, an attractive

experience, full of happiness throughout space and time, which has simple rules and which can be played by everyone" (p.83).

2.3 Rules for practising the national sport – oina

Oina is played by two teams of 11 players each in two unlimited rounds, with a 5 minutes break, on a rectangular field having the following measurements: for seniors/juniors I: 70m length and 32m width (see figure. 1), for juniors II/juniors III: 58m/ length and 26.5m width. In the first round, a team hits and the other catches, while in the second round the teams exchange places. The team which gains the most points, wins.

2.4 The description of the materials used

The materials used in an oina game are: the oina ball which is spherical and must have 8 pieces of leather cut in equal curves and sewed among them. The ball is stuffed with natural hair of horse, cattle or pig.The bat must be made by hard wood (Beachwood, phrasing).

Fig. 1 The oina ball

Fig. 2 The oina bat

2.5 The player's tasks when hitting the ball

Most of the time the trainer is the one who makes the tactics, depending on the player's experience, their physical abilities and qualities.

As in other sports, sometimes, in an oina game there are similar tactics and others which may differ. Therefore the player's ability to master a technique can influence various combinations of the team's tactics. The trainer is the one who knows whom of his players can hit the ball the best (the players who can hit over 60-70m long), the players who can hit the best from the point of view of the tactics, which players are the best defenders and the time in which a player can make the run.

Considering the physical training of a player, the way in which they interact during the training sessions, the trainer will decide which player will hit the ball first, second and third.

This order is essential in an oina game because it is decided according to the player's ability (one might hit the ball the farthest, one hits perfect tactics, the other one is a good defender and so one).

These particularities of the players must be exploited in a good way, since the rules allow forming groups when players enter the field. Depending on the players' hits and on the score of the game, the groups can be fixed and mobiles.

CHAPTER III
A BIOMECHANICAL ANALYSIS OF THE OINA GAME

3.1 Historical analysis of the movement of the human body

Biomechanics is the science which analyses the movement of the human body and which studies the interaction between the external forces and the locomotors system. Following the biomechanical analysis a trainer can recommend exercises to improve some defficitary movements of his players or practising others which are specific to this sport.

The mechanical behaviour of the human body undergoes the general laws of movement:

- the law of inertia: a body is resting or is moving fluently as long as there are no other forces which may disturb it.

- the law of acceleration: a body's acceleration is proportional with the force which acts over it and disproportional with its weight.

- the law of action and reaction: for every mechanical action there is an equal reverse reaction.

The movements of the human body is formed by a cartezian point of reference, formed from 3 orthogonal plans: the frontal plan, the sagittal plan and the transversal plan and they can be of translation and of rotation.

3.2. The importance and the purpose of the biomechanical analysis of the oina game

Biomechanics in the field of physical education and sport has the purpose of improving the movements and the technical executions of the players through measurements and analysis made with the help of modern technology.

With the help of video equipment we can record the human movements in thousand times per second in order to observe the particularities if rapid moves in the oina game.

3.2.1. The biomechanical of hitting with an oina bat

The hitting with an oina bat is a technical element through which the team can organise its group defence or it can achieve points, according to a well-established tactics (Potre&Frangulea 2011).

The hit with an oina bat has the following steps:

- *Giving the ball to be hit*

The oina game starts by a player giving the ball to be hit. The way a player gives it can make the difference for the co-player when hitting it with an oina bat. The player who serves can choose the position from which he serves. When hitting the ball the player chooses the best moment. According to some specialists, this action can happen in three ways:

- visual information which are predictive and which regard the place where the ball will be at a certain moment;
- coordination which is made through the correct positioning of the ball based on the visual information and of cerebral commands which are received;
- using the previous training to complete the missing information

Regan stated in 2011 that the retina catches binocular and monocular correlations of the instant movement of the ball's directions and also in depth in the case of a ball which moves at a constant speed.

At the same time, Roata considered in 2018 that in order to have a good hit, the player must take into consideration two points: the maximum height which must be reached by the ball which leaves the palm, and the moment when the bat must hit the ball.

- *Hitting the ball with the oina bat*

The ball is set into motion by hitting it with an oina bat. In order to follow the rules, the hit mustn't send the ball over the lines from the left and right of the field and it must be executed only once by each player.

A player can hit the ball depending on the length and the weight of the oina bat (Daniel & Russell, 2005), and also on the material of the bat (Vedula& Sherwood, 2004).

This is very important, tactically speaking and it can represent a key point in the match because it can get extra points and therefore we can state that it is a good hit or it can solve a tactical situation executed during the training sessions with the purpose of helping other co-players which are not very good at the defence, but who have a great speed.

3.2.2. The biomechanical behaviour of the upper and inferior limbs when hitting with an oina bat

In order to hit the ball with a bat held in two hands, the legs must be spread at the level of the shoulders. The left leg is slightly in front of the other so that the top of the right foot is in the half of the left foot. Both legs must be in a triple extension so that the player can do a balancing act at the coxfemural articulation in the sagittal plan.

The abductor muscle of the hallux and the abductor muscle of the little toe make a static action at the planetary dome. In this position, the limbs help creating the balance and the pelvis makes only symmetrical moves in the sagittal plan, around the biacetabulary axis, with the help of iliopsoasis muscles, maximum gluteus and ischiocruralismusles (Papilian, 1982).

The iliopsoas muscle has a static role when it presses on the femur allowing the pelvis not to fall backwards. Therefore it is a very important stalibizator of the trunk.

During an oina game, the bat is held and the upper limbs are projected backwards to signal the co-player waiting to serve at what height he wants to hit the ball.

After the ball is hit and has left the hand, the player who hits it continues the movement through a rotation of the coxfemural articulation towards left, an external rotation towards the left and an internal rotation towards the right side.

Then the weight centre moves from the left foot to the right one, through the action of the tensor muscle of the wide fascia, the left leg standing on the top through the contraction of the gastrocnemius muscle, solearius, plantaria helped by the Achilles' tendon.

As the player changes the weight centre forward, the force on the front leg is 123% off the weight of the whole body, as Welchetal stated in 1995. The baseball players succeed in speeding the segment around its axis through spinning their hips and shoulders. The result of this kinetic movement increases the hit of the bat during the hit.

3.2.3 The biomechanical behaviour of the trunk during the hit with an oina bat

The trunk spins easily from the left side to the right one flexing a little when waiting for the ball to be served. The moment the ball has reached the optimal height, the trunk spins with all its force towards the left along with the extension of the spinal column fact which will give the bat the force and the speed for the hit.

The axial rotation of the trunk being calculated by Tagoetal, in 2005, as the angle between the pelvis and the upper trunk in transversal plan, results in a bigger stress on the trunk after the contact with the ball. Messier &Owen (1985) stated that the horizontal deceleration of both hips, even before the contact of the bat with the ball was mostly due to the decrease of the antero-posterior forces.

PART II

CHAPTER IV

PRELIMINARY RESEARCH REGARDING THE OPTIMIZATION OF THE HIT WITH THE BAT IN AN OINA BAT THROUGH A BIOMECHANICAL ANALYSIS

4.1. The premises of the research

The oina game being a national sport hasn't been scientifically researched. Studies could have led to the development to some standards in the training sessions. It hasn't received any objectives of the training programmes and the developing of some specific tests for movement.

4.2 The purpose of the preliminary research

The preliminary research has the purpose of measuring the mechanical parameters of the movement by analysing the temporal variations of the angles created among different segments of the body (shoulders, hips and also those parts responsible for flexion and extension of the elbow and knee), the variation of speed, force and acceleration during the hit with a bat, to determine the movement scheme of the upper limbs, stressing the values of the kinetic parameters of the bat which are linked to the values of the speed and acceleration of the torsion angle.

4.3. The hypothesis of the research

We assume that there is some qualitative repetitively of the cinematic parameters of the three hits with the bat measured through video methods in the laboratory.

We assume that the hit with a bat in the lab is very closed to the real hit on the field, in terms of speed and acceleration, and also of the angles that are formed when determining the trajectory of the ball across the field.

4.4. Objectives of the preliminary research

1. Evaluation of the trajectory of the ball on the field based on lab measurements and of mechanical characteristics of the sport materials used.
2. Calculating the movement scheme of the upper limbs when hitting with a bat, predicting the cinematic parameters involved in the hit.

3. Finding the biomechanical parameters which allow the optimization of the training from the point of view of general physical training and technical training.

4.5. Tasks of the preliminary research

1. Selecting the subjects;
2. Establishing the work methodology and the parameters which will be followed;
3. Measuring the angles which are formed at the level of the arm and the trunk during the hit with a bat;
4. The optimization of the technique of hitting with the bat, comparative analysis between the hits with the bat based on the analysis of the cinematic parameters linked to the values of the speed and acceleration of the torsion angle;
5. Formulating the conclusions of the preliminary research;
6. Disseminating the results.

4.6. Organising the research

Preliminary research was conducted between April the 1st – October the 1st 2018 on 6 subjects (6 boys having an average age of 42).

Table. 1 *Values of the main anthropometrical parameters of the analysed subjects*

	Weight (kg)	Height (m)	IMC (kg/m^2)
S1	87	1.75	28.40816327
S2	59	1.72	19.94321255
S3	78	1.75	25.46938776
S4	92	1.92	24.95659722
S5	83	1.77	26.49302563
S6	92	1.9	25.48476454

4.7. Stages of the preliminary research

The preliminary research was developed in three stages as following:

- the study of sports literature;

- experimental measurement and recording of mechanical parameters during the hit with the bat through the RSscan Platform;
- experimental measurement and recording of cinematic parameters of specific movement when hitting with an oina bat;

4.8. Research methods

The utilised research methods were:

- the method of biographical study;
- the method of systematic observation;
- the method of pedagogical experiment;
- statistical method;
- mechanical and biomechanical methods of analysis.

4.9. Biomechanical and mechanical analysis

In order to obtain an improvement of the speed and the trajectory of the ball in an oina game, this study is meant for achievement of an analysis of the cinematic parameters of some particular points from the players' body and from the utilised tool (the oina bat). The experimental measurement of the trajectories of these points was achieved by using the complex equipment VICON (which will be further described), and the biomechanical analysis of those parameters was achieved with the software NEXUS as part of the video equipment.

From the point of view of the biomechanics we measured and analysed the angles formed at the level of the upper limbs and the torsion angle and tried to link them with the speed of a point of the bat where it is supposed to hit the oina ball.

Since the measurements specific to the hit with the bat have been done in the laboratory, it was compulsory to simulate and calculate the trajectory of the ball on the field after the hit.

Hitting the ball with the bat is done in a very short time and this phenomenon has been considered to be similar to a rubber clash. Through measurements with the same video equipment VICON, we have calculated the parameter of the returning coefficient.

4.10. The equipment used for measurements

Fig. 3 Techniques and InnovativeProcesses in Bioenginery Laboratory

The complex system of cameras and video editing VICON (https://www.vicon.com) is part of the equipment of the Laboratory of Innovative Techniques and Processes in Bioinginery (figure. 3) from the Research Infrastructure in Applied Sciences (INCESA) of the University of Craiova. This system can predict and calculate the trajectories of the marked points on the biomechanical system which is studied through continuous recording with 14 high-tech cameras: (https://vicon.com/press/2015-12-02/vicon-vantage-helps-derby-university-search-for-the-perfect-golf-swing) (Fig. 4).

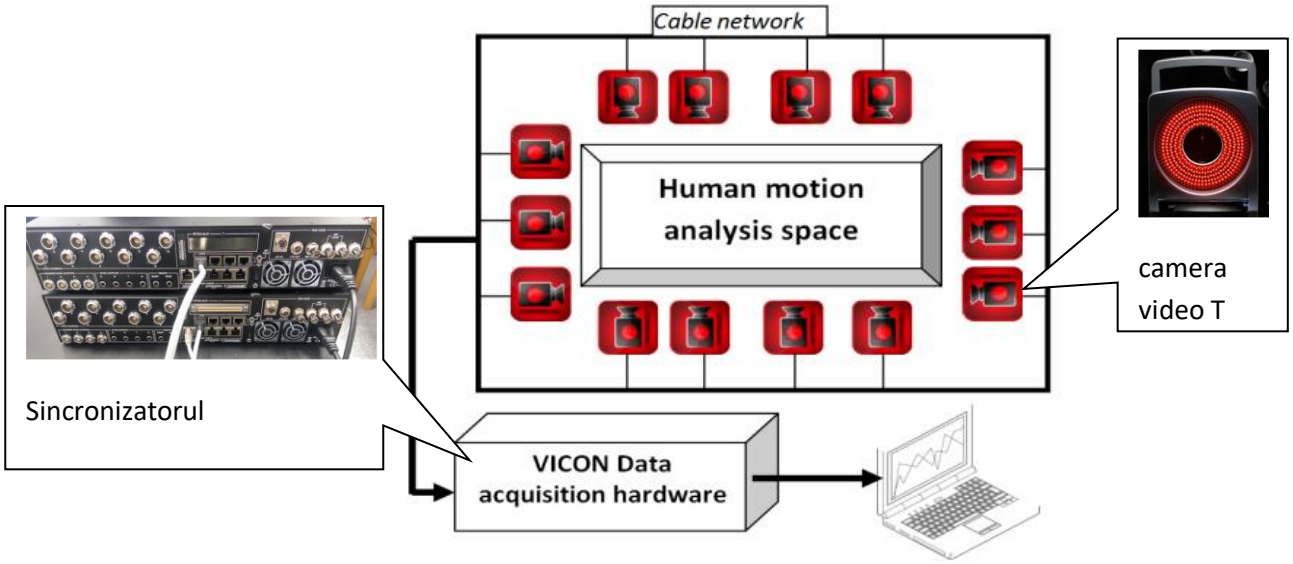


Fig. 4 The diagram of the Vicon system with its 14 ultra-fast video cameras T/series

After gathering the measurements and the data (the trajectories of the marked points) with the soft ProCalc of the Vicon system we determined the angular amplitudes among various segments of the real biomechanical system and we made a graphic variation of the cinematic parameters (the trajectories of the marked points in comparison with the global reference of the work space) and the angular parameters (in comparison with points set on the analysed subject's articulations).

The restitution coefficient ($CR=v_2/v_1$), represents the result of the speed of the ball after the hit with the bat (v_2) and its speed before its contact with the bat (v_1).

4.11. Sport materials used and the experiment

4.11.1. The Oina Ball

We have selected 17 oina balls: 3 of them were completely new, and 14 were already used and in different stages of ageing depending the number of games they had been used.

4.11.2. The Oina Bat

The oina bat is 1m long but its weight can vary.For this experiment there were used bats made of Beachwood and acacia (figure. 2). The average diameters of the hit zone of the ball are about 45mm.

4.11.3. The Experiment

The experiment concentrated on determining the restitution coefficient which can influence the score in an oina game. We have made over 300 hits (bat-ball), with sending a marked ball (figure 5) in free fall, from a vacuum pump set at an adjusted height (figure 6).

Fig. 6 Vacuum pump ***Fig. 5*** Marked oina ball

The balls were sent from two different heights:

H=1000 mm

H=1400 mm.

For each of the 17 balls we have made 3 recordings.

The experiments were repeated for the both kinds of bats.

The bats were carefully fixed on the ground.

4.11.4. Pressure Platform RSscan

Fig. 7 Image of RSscan platform – FootScan Gait Analysis soft

CHAPTER V
RESULTS OF THE PRELIMINARY RESEARCH AND THEIR INTERPRETATION

5.1 Results of the evaluation of the sportive equipment used in the oina game

The data – the trajectories of the ball before and after the hit were recorded at a frequency of 400Hz with the complex system Vicon.

The Nexus soft of the Vicon system allowed the calculation of the derived cinematic parameters: the speed and the accelerations before and after the hit. These parameters were utilised for finding the restitution coefficient.

5.1.1 A statistic analysis of the experimental data resulted from the measurement of the restitution coefficient

Tabel. 2 *Values of the CR statistical parameters for all the 306 tries*

Analysed Variable	No. of determinations	Average CR	Average Square Deviation	Dispersion	Asymmetry
CR	306	0.4808	0.0649	0.004	0.477

Table. 3 *Statistical values of CR depending on the tries*

Type of CR	No. of Determinations	Average CR	Average Square Deviation	Dispersion
CRH_F1000	51	0.494912368	0.0541066281	0,003
CRV_F1000	51	0.511902216	0.0872269120	0,008
CRH_F1400	51	0.451743138	0.0367144483	0,001
CRV_F1400	51	0.470232453	0.0832437657	0,007
CRH_S1400	51	0.486493663	0.0401105187	0,002
CRV_S1400	51	0.469693553	0.0546267155	0,003

5.1.2. Interpretation of the results from measuring the restitution coefficient

1. Variation coefficient (the last column in Table 3) has at all tries, the value under 0.17, which means that the dispersion is a small one and the average is strictly representative. That is why there is no need for an analysis of the statistical data divided in groups, for example the division in groups of the wear of the cover of the ball.

2. From Table 2 results an average value of the CR of 0.4808mg, and the average deviation is of 0.0649, which means an approximatively 68% of the CR values calculated experimentally between the range of 0.4808+/-0.0649, which are between 0.4159 and0.5457.

3. From the analysis of the experimental data statistically interpreted we have drawn the following conclusions:

- CR is smaller at the new balls which have never been used in a game (0). The biggest CR values have been recorded at the balls with a wear degree of 1.

- There is no correlation (correlation coefficient Pearson = 0.227) between the mass of the ball and the CR for all the 306 measurements.
- There is a powerful correlation between the CR of the 17 balls, important for the balls M1 with M5 and M14 and of medium intensity between the balls: M0 with M6 and with M13, M1 with M16, M2 with M4 and M13 with M16. Testing the signification of these correlations was made with Test 1 and the value of the coefficient of signification is under 0.01 (which shows a significant correlation).
- The values of statistic parameters were determined with SPSS V2.0 soft which calculated the values of the CR measured experimentally.
- CHR_F1400= The coefficient of return, determined from the measurement of the height of lift and fall, on a beeach cane from the height of 1400mm.
- CRH_S1400= Coefficient of Return, determined by measuring the height of rise and fall, on an acacia cane from a height of 1400mm.

5.2. Results obtained through the analysis of the RSscan plantogram

- We noticed that all the weight is distributed on the support leg, in our case the right foot, while the left foot supports a lesser weight and has the role of equilibrium and for preparing for the next step.

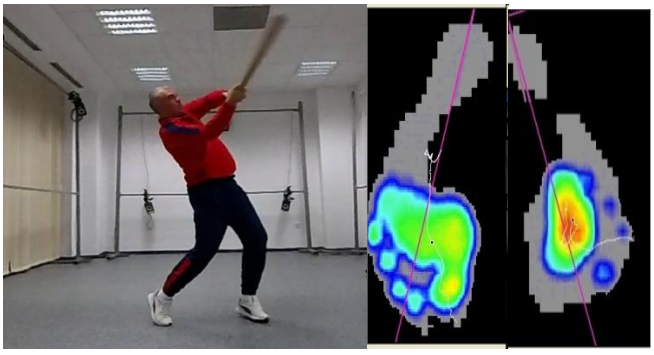


Fig. 8 The Plantogram obtained from the pression platform, at the moment of the hit with the oina bat

We noticed an important difference between the right foot and the left one, with a bigger pressure on the forefoot area which means an increased force on the hip muscle and paraspine muscle whose action can reduce the risk of loosing the equilibrium during the hit with the bat.

5.3. Results of the calculation of the cinematic parameters of the hit with an oina bat through recordings and video analysis

Video measurements have been made in the Innovative Processes And Techniques InBioenginery Laboratory.

5.3.1. Recorded data

We recorded the trajectories of characteristic points marked on the subject's body. The soft attached to the equipment interpreted the data obtained and gave information on the angular amplitude, speed, angular and linear acceleration for the concerned areas involved in hitting the ball with an oina bat.

We analysed the angles from the upper limbs to identify if the angles created at the level of the upper limbs are created by the hit with the bat.

- The angle formed between the arm and the trunk for the upper left and right limb:

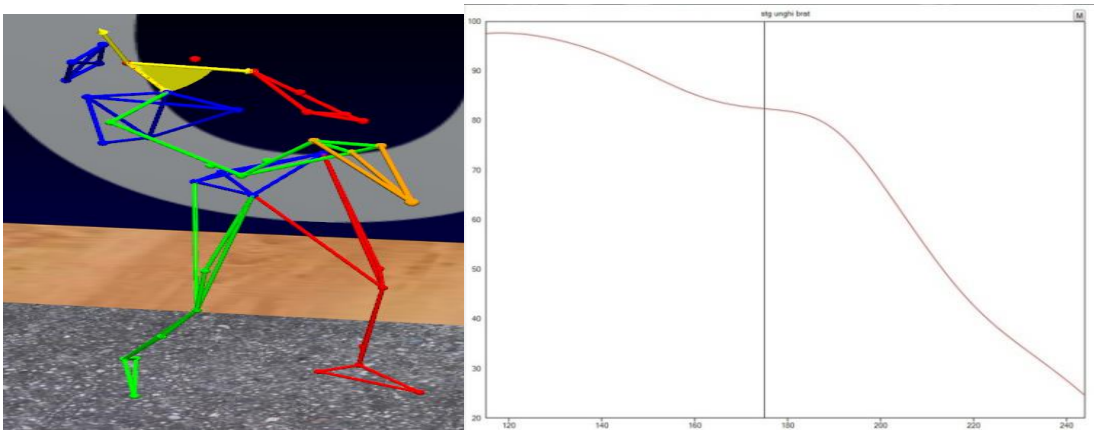


Fig. 9 Variation of the angle between the left arm and the trunk

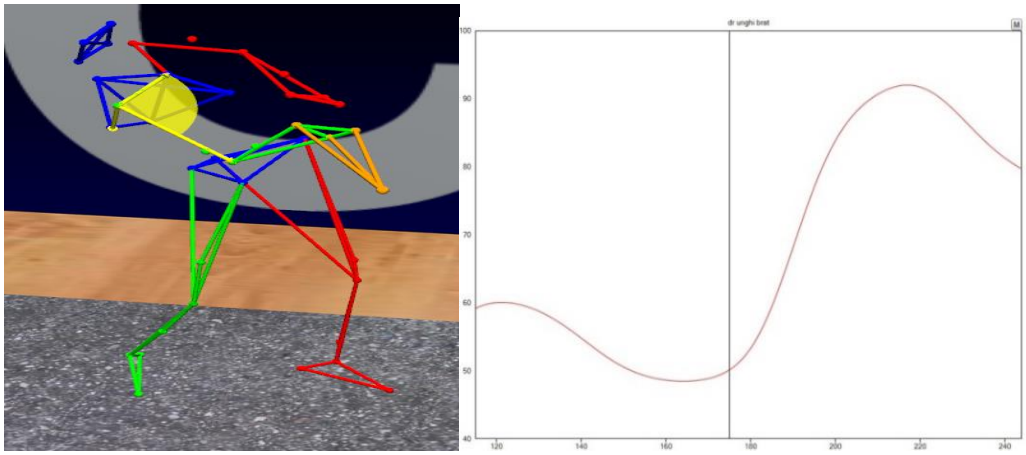


Fig. 10 Variation of the angle between the right arm and the trunk

- The angle formed between the arm and the forearm (elbow) for the upper left and right limb when hitting with the bat:

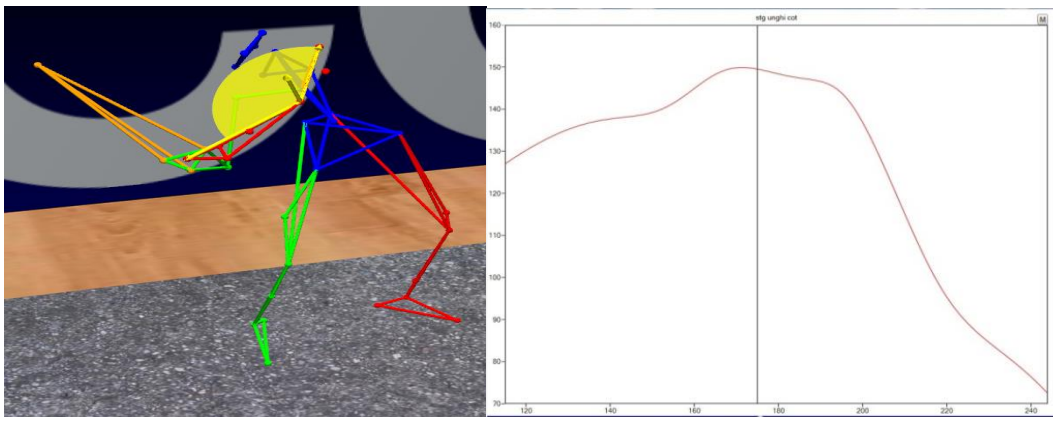


Fig. 11 Variation of the angle of flexion, extension of the left elbow

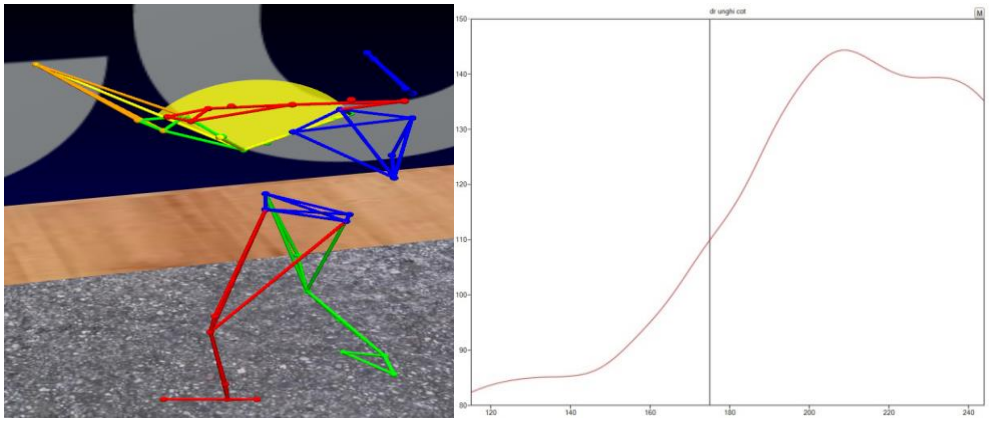


Fig. 12 Variation of the extension flexion angle of the right elbow

The following average values of the kinematic parameters were obtained:

- The angular velocity at the level of the left arm is 347º/s, and at the right 504º/s.

- Variation of the angular velocity of the angle of the left and right elbow at the hit with the bat:

- the angular amplitude at the level of the left elbow is 55º,14, and at the right one is 73º;

- Variation of the angular acceleration of the angle of the left and right arm at the hit with the bat:

- the angular acceleration at the level of the left arm is 7200º/s^2, and at the right one is 12800º/s^2;

- Variation of the angular acceleration of the angle of the left and right elbow:

- the angular amplitude at the left arm level is 41º,28, and at the right one is 39º,28;

- the angular velocity at the level of the left elbow is 722º/s, and at the right one is 620º/s.

- the angular acceleration at the level of the left elbow is 19300º/s^2, and at the right one is 20000º/s^2.

5.3.2. Interpretation of the results of the measurement of kinematic parameters

From this analysis it follows that the players have an angular velocity at the level of the right arm with 31.2% higher than the left one and an angular velocity of the left elbow with 14.2% higher than the right elbow.

This evolution of the angular velocity values, different right-left, requires the development of an explosive type muscular force at the right arm, which limits possible injuries and which stabilizes the kinetic chain of the upper right limb in speed force regime (Hennessey & Johnson, 2000). On the other hand, at the level of the left arm, there is a need for a muscular training programme in which the focus should be on the developmentof the isometric force, which allows stabilization of the left upper limb, which has the role of taking over the force generated by the contralateral segment.

The complex system of recording and analysis VICON, allowed to visualize the trajectory of the bat maneuvered by the sportsman in the movement of the hit with the bat and the decomposition in the horizontal and vertical components of the speed of the bat tip (Figure. 13), specifying the position of the sportsman, when these components of the speed are maximum.

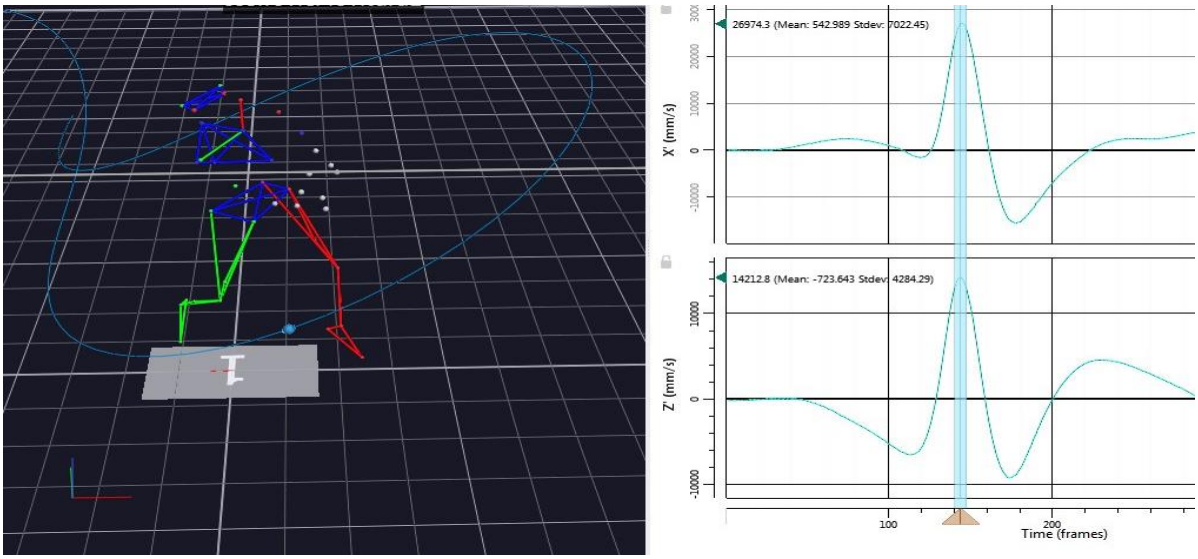


Fig. 13 The trajectory of the tip of the bat and the variation of the velocities of the tip of the bat in the field direction and in the vertical direction. The current position is where the bat hits the ball.

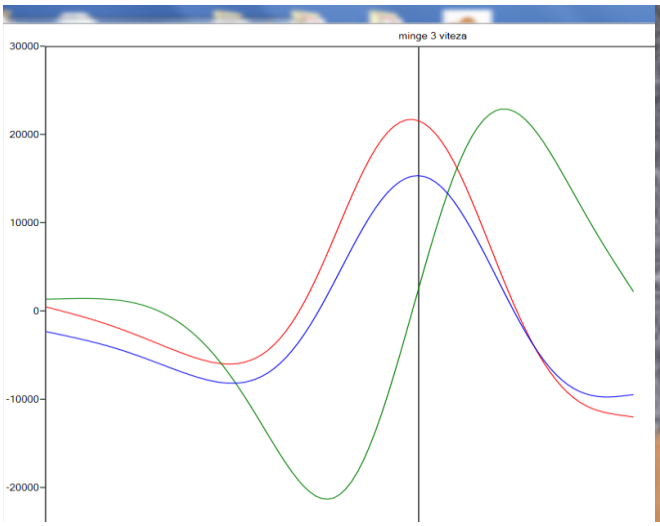
At the same time, it was observed that the value of the torsion angle acceleration is zero or has a very small value, so the speed of the same angle is maximum. The torsion angle of the sportsman was established as the rotation angle around the axis of the spine, between the axis of the shoulders and the axis of the pelvis.

In the work in extenso, the following graphs are presented, for the 6 sportsmen in the experimental group:

- the variations of the components of the angular velocity of the point on the bat where it hits the oina ball, specifying the position where the horizontal speed (blue curve) and vertical speed (red curve) are simultaneously maximum;
- the position of the sportsman (seen from above), when the two components of the speed specified above are maximum;
- the variations of the acceleration and the speed of the torsion angle, specifying the position at which the components of the aforementioned speed are maximum.

Table.4 *The values of the kinematic parameters of the bat correlated with the values of the speed and acceleration of the torsion angle*

The name of the subject being analyzed	The speed of the tip of the bat (of the oina ball) (mm/s)			No. Frame corresponding to maximum speed	Torsion angle acceleration (deg / s2)	Torsion angle speed (deg / s)
	x	y	z			
S1	19995	456	13758	295	-830	-138
S2	17053	-3381	13509	318	-1251	-59.39
S3	25509	-4154	14368	209	-2115	-83.41
S4	19528	1775	12041	181	-2118	-131
S5	24242	-1328	14597	167	-1509	-44.68
S6	21646	2200	15380	177	-490	-102



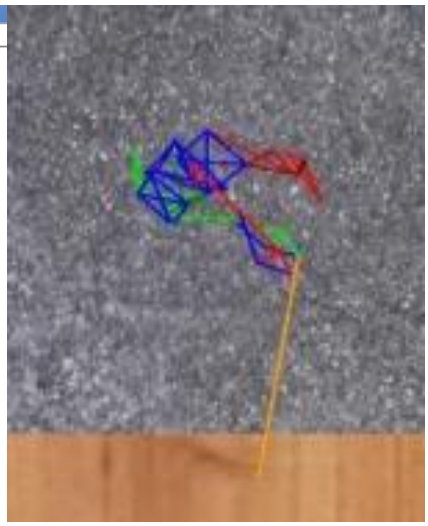
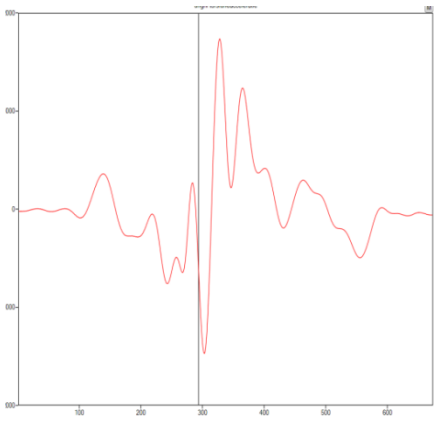


Fig. 14 Subject S1 - Speed of the tip of the bat when hitting the ball

Fig. 15 Subject S1 -Position of the body

It can be seen in figure. 14, for the S1 sportsman, the variation of the angular velocity of the point on the bat where he hits the oina ball (the horizontal speed is the blue curve and the vertical speed is the red curve). The two components are simultaneously maximum.



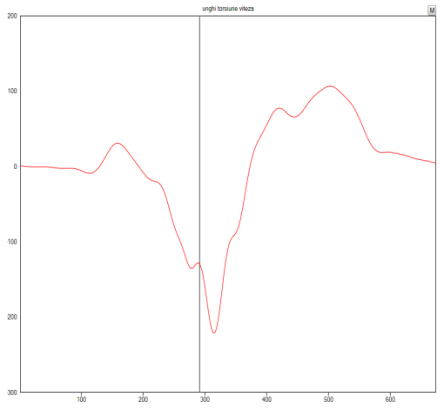


Fig. 16 Subject S1 - Angle acceleration of torsion

Fig. 17 Subject S1 – Angle speed of torsion

Also for the S1 sportsman, the variations of the acceleration and the speed of the torsion angle are maximum (red curve) when the ball should be hit with the bat.

5.4. Conclusions following the biomechanical analysis of the torsion angles

1. The times at which the player should hit the ball with the bat have been chosen so that the speeds of the bat in the direction of the field (red curve) and vertical direction (blue curve) are maximum.

2. At these times, the values of the torsion angle accelerations have the values close to zero, so the speeds of this angle have maximum values or close to the maximum.

4. Since the speeds are maximum, there is a transfer of energy from the bat to the ball at the maximum kinetic energy value that the bat can have, taking into account that Ec = mv2 / 2.

5. The speed of the ball will be equal to the speed of the bat multiplied by the coefficient of return, which is $v_2=v_1xCR$.

6. For all players it is a good synchronization of the maximum values of the speed of the bat in the direction of the field and in the vertical direction.

7. The higher the speed of rotation of the bat, that is when the speed of variation of the torsion angle is higher, the higher the horizontal velocity of the ball.

8. The higher the linear velocity in the vertical direction of a point on the bat, which is considered to hit the ball, the higher the vertical velocity of the ball.

5.5. Conclusions of the preliminary research

The specific results of the biomechanical analysis of the hit with the bat can represent a possibility of developing the specific programme of physical training for the correct execution of the hit of the oina ball with the bat in order to obtain points and to make a difference in the games in which the teams have close values.

The analysis of the video recordings made revealed that the equipment used to measure three-dimensional movements is efficient. After analyzing the data recorded using the complex VICON Figure. capture and processing system, it has been demonstrated that it can be used in determining the motion of the upper limbs when hitting with the bat, estimating the kinematic parameters involved during the use of the bat and measuring the angles that are form at the level of the arm and between the arm and the trunk, but also the torsion angle that we consider the most important.

PART III

EXPERIMENTAL RESEARCH ON THE OPTIMIZATION OF THE HIT WITH THE BAT IN THE OINA GAME BY BIOMECHANICAL ANALYSIS

CHAPTER VI

ORGANIZATION AND DEVELOPMENT OF RESEARCH / RESEARCH METHODOLOGY

6.1. The premises and hypotheses of experimental research

6.1.1. The premises of experimental research

The training in the oina game is decisive both in the tactics of the game and in the level of individual technical improvement of the hit with the bat, in which respect the coach, in order to achieve a progress in performance, from the junior level I, must also be documented and keep up with the latest research to get a senior level.

6.1.2. Purpose of experimental research

The experimental research aimed to achieve a hit with the bat in order to analyze the values of the kinematic parameters of the bat correlated with the values of the speed and acceleration of the torsion angle to validate or invalidate the hypotheses formulated in relation to the designed training project.

6.1.3. Hypotheses of experimental research

1. We suppose that the optimization of the hit with the bat can be done based on the analysis of the kinematic parameters of the bat.
2. Suppose that there could be a correlation between the kinematic parameters of the bat and the values of the speed and acceleration of the torsion angle.
3. Suppose that the torsion angle of the trunk is a biomechanical parameter by which we can efficiently speed the tip of the bat during the hitting.
4. Suppose that the introduction of special programmes of technical and physical training for this type of training will contribute to the improvement of the hit with the oina bat.

6.1.4. Objectives of experimental research

1. Performing some measurements and comparative analyses of the values of speed and acceleration of the torsion angle during the hit with the oina bat, between the subjects before and after the specific training.

2. Carrying out measurements and analyses regarding the correlation of the speed of the bat, both vertically and horizontally with the speed and acceleration of the torsion angle before and after the specific training.

3. Carrying out measurements and comparative analyses between the executions and the efficiency of the hits with the oina bat performed by the subjects.

6.1.5. The tasks of experimental research

1. Selection of the group of subjects according to the inclusion criteria;
2. The classification of the subjects by the type of player according to the regulation of the Romanian Oina Federation;
3. Segmental biomechanical analysis;
4. Data recording;
5. Analysis and interpretation of results;
6. Drawing up the final conclusions.

6.2. The organization of the research

6.2.1. The place of the experimental research

The research was carried out in the Laboratory of Innovative Techniques and Processes in Bioengineering, from the Research Infrastructure in Applied Sciences (INCESA), using the complex image capture and processing equipment, in the Training Room of the C.S.M. BĂILETI PROGRESS, but also on the football field in Băilești. Regarding the part of theoretical foundation, mainly focused on data and information collection, it has also been carried out in other locations, such as: Lucian Blaga Central University Library Cluj-Napoca, National Research Institute for Sport Bucharest, the Library of The Faculty of Physical Education and Sport Cluj-Napoca.

6.2.2. Subjects included in experimental research

The experimental research was carried out between October 2018 - December 2019, during which the documentation on the game of oina, referring data, theoretical foundations of the biomechanical analysis were continued. The criteria for including the subjects, the evaluation methods used, the measurement techniques, the intended parameters were established.

In order to make the best selection, we studied the results obtained by the girls' teams at national level, choosing as subjects for research the components of the team from C.S.M. Băilești Progress.

6.2.2.1. Characterization of the team

All the subjects included in the research had the quality of junior sportsmen II and I of the C.S.M. BĂILESTI PROGRESS, legitimated within the Romanian Oina Federation, members of the same team, following previously established training plans, having the same annual training programme, therefore, the selection of these players was made by the coach.

6.2.2.2. The influence of anxiety in the hit with the bat on the subjects

The hit of the ball with the bat has a greater degree of difficulty in terms of finding the optimum balance between the maximum height of the trajectory of the ball and its length, being also linked to the way the co-player offers the ball to achieve the hit.

Thus, the fear of being hit or missing the hit of the ball, the concern of not delivering a ball at the height required by the co-player or of not performing a hit that will bring points to the team, the anxiety, uncertainty and distrust in the strength of their co-player lead to the performing of a defective hit, at a bad timing or lack of coordination, which can put their mark on the game.

6.2.2.3. Anthropometric characteristics, segmental morphological characteristics

The measurements were made on a batch of 17 sportsmen, aged 16-18 years from the C.S.M. Băilești Progress practitioner of the game of oina, who simulated in the laboratory the strike with the specific bat of the game of oina.

Table. 5 *Values of the main anthropometric parameters of the analyzed subjects*

Sportsmen	Height [m]	Weight [kg]	IMC [kg/m^2]
S1	1.68	64	22.68
S2	1.68	50	17.72
S3	1.78	60	18.94
S4	1.65	55	20.20
S5	1.64	55	20.45
S6	1.66	62	22.50
S7	1.69	58	20.31
S8	1.65	53	19.47
S9	1.62	49	18.67
S10	1.72	60	20.28
S11	1.64	58	21.56
S12	1.67	53	19.00
S13	1.60	50	19.53
S14	1.60	55	21.48
S15	1.62	97	36.96
S16	1.51	37	16.23
S17	1.63	49	18.44

Table. 6 *Calendar of research stages*

No.	**2018** Etapa/lunile	01	02	03	04	05	06	07	08	09	10	11	12
A	**Cercetarea preliminară**												
1	Documentarea în literatura de specialitate												
1	Testare materiale sportive												
2	Înregistrarea parametrilor de presiune cu platforma RsScan												
3	Evaluarea biomecanică și analiza rezultatelor înregistrate												
B	**Cercetare experimentală**												
1	Selecția subiecților și testarea inițială												
2	Analiza biomecanică a execuțiilor												
3	Implementarea programului de antrenament specific												
4	Reevaluarea jucătorilor și validarea rezultatelor												
5	Prelucrarea, analiza si interpretarea concluzilor finale												
No.	**2019** Etapa/lunile	01	02	03	04	05	06	07	08	09	10	11	12
A	**Cercetarea preliminara**												
1	Documentarea în literatura de specialitate												
1	Testare materiale sportive												
2	Înregistrarea parametrilor de presiune cu platforma RsScan												
3	Evaluarea biomecanică și anlaliza rezultatelor înregistrate												
B	**Cercetare experimentala**												
1	Selecția subiectilor și testarea inițială												
2	Analiza biomecanică a execuțiilor												
3	Implementarea programului de antrenament specific												
4	Reevaluarea jucătorilor și validarea rezultatelor												
5	Prelucrarea, analiza si interpretarea concluzilor finale												

6.3. Research methods

- The method of bibliographic study
- Observation method
- The method of the pedagogical experiment
- Test method
- The investigation method
- Case study method

• Methods of biomechanical analysis

• Graphical and table method.

• Statistical method

Among the methods of partial research applied in statistics, the selection process holds first place today in terms of actuality and practical value. The objective of the research within the selective method is not to know the partial collectivity but to characterize the total collectivity from which the analyzed sample was selected. In this study, the selective research was carried out on a limited selection community, given the small number of sportswomen performing the game of oina and being legitimate at the national clubs.

Table. 7 *Statistical parameters for the total collectivity and for the selected collectivity*

Parameter analyzed	HEIGHT		WEIGHT	
	the whole collectivity	the selected collectivity	the whole collectivity	the selected collectivity
Average	1.65125	1.64875	56.5480769	56.4375
Standard deviation	0.0624684	0.059203	9.66715971	12.4738059
Median	1.65	1.645	56	55
Module	1.64	1.68	60	55
The minimum value	1.45	1.51	37	37
The maximum value	1.79	1.78	97	97
Number of subjects	104	17	104	17

CHAPTER VII

SPORTS TRAINING - BASIC PROCESS FOR OBTAINING SPORTS PERFORMANCE IN THE OINA GAME

7.1. Sports training

As it is well known, the training of sportsmen is influenced by physical, technical, tactical, theoretical and psychological training. The importance of all these in oina is given by the competition calendar, slightly different from other sports branches as it starts in May and ends in December. The trainer, depending on the possibilities of the club, referring to the material basis: the insufficiently large room for playing the game of oina with 11 players, establishes the planning and type of the training taking into account the particularities of the age, training and health of the athletes.

The athlete who evolves in batting must adapt according to the evolution of the game and the score by trying through the hit that he performs to score points or if he does not create an advantage for teammates, thus allowing them to form fixed, mobile or semi-mobile groups.

It is well known that any failure with the bat can create a big disadvantage for the team that performs the batting since some of the teammates will have to enter the game to be played. Athletes need to understand that the ball must be hit with the bat, giving it a trajectory that allows teammates the greatest advantage. For a better knowledge of the technical and tactical elements we must have a good theoretical training, which depends on the ability of the coach and the collectivity from which the team is formed.

Control tests

1. The hit with the bat / Simulation of the hit with the bat against time - 30 sec.

In particular, the execution speed is monitored (number of hits performed within 30 seconds).

2. The hit with the bat of the ball positioned on a support at a height determined on the basis of anthropometric criteria.

This exercise aims to change the trajectory of the bat (the ball being thus hit at the optimum height), so the correction of individual mistakes that can lead to a weak hit. At the same time, the

aim is to hit the ball in the lower third of it to give both height and length to the trajectory of the ball.

3. The player offers his bat for the ball (self-propelled ball), about 90-100 cm (the equivalent of the length of the bat) upwards, to hit the ball at an angle of about 40^0-45^0 from the bottom up.

Through this exercise the subject improves his coordination and speed of execution, he must form his skill of hitting the ball at a certain point (called by us the optimal point).

4. The strike with the bat of a ball offered by the teammate. There will be 10 bats in the form of a contest, with the aim of perfecting the strike itself, following the correction of individual mistakes and making extra points.

5. The player is positioned facing the wall with a 1 kg medicinal ball, held at chest level with outstretched arms. In 30 seconds he will try to perform as many throws with the ball in the wall. This exercise aims to develop the specific strength (at the level of the torso and upper limbs, the muscles involved in twisting the torso).

7.2. Training programmes for the hit with the bat in the oina game

The program contains exercises for developing the speed of the execution and the much-needed explosive force in the batting, but also exercises in which the athletes learn and strengthen their skills of hitting the ball from a certain angle to obtain a trajectory according to the situation of the game. The number of repetitions has been increased being adapted according to the particularities of each player and the tasks they have, according to the number they occupy in the batting grouping. The correct execution of the movements was followed in order to correlate the torsion angle with the speed of the bat on the two axes, horizontal and vertical.

Based on the identified evidence, we will try to develop a methodology to optimize the batting in the game of oina.

Training programme 1

	Programme 1	Description	Instructions	Dosage
1		Simulation of the batting in the air without a ball	Execution of the batting with the bat at maximum speed throughout the entire round	6 halves, for 30 seconds, pause 1 minute
		The player offers his bat (self-propelled ball), at approximately 90-100 cm (the equivalent of the bat length) upwards	To hit the ball at an angle of about 40^0-45^0 from the bottom up	5 sets of 10 balls each of the two athletes, one performs 10 hits and the other retrieves the balls. The players rotate between them.
		Side passes with 1kg medicine ball on the wall	Left - right focus on the torso torso	6 halves, for 30 seconds, pause 1 minute

CHAPTER VIII

PRESENTATION AND INTERPRETATION OF RESULTS

8.1. The results of the application of the questionnaires in order to characterize the team from the point of view of the influence of anxiety in the hit with the bat

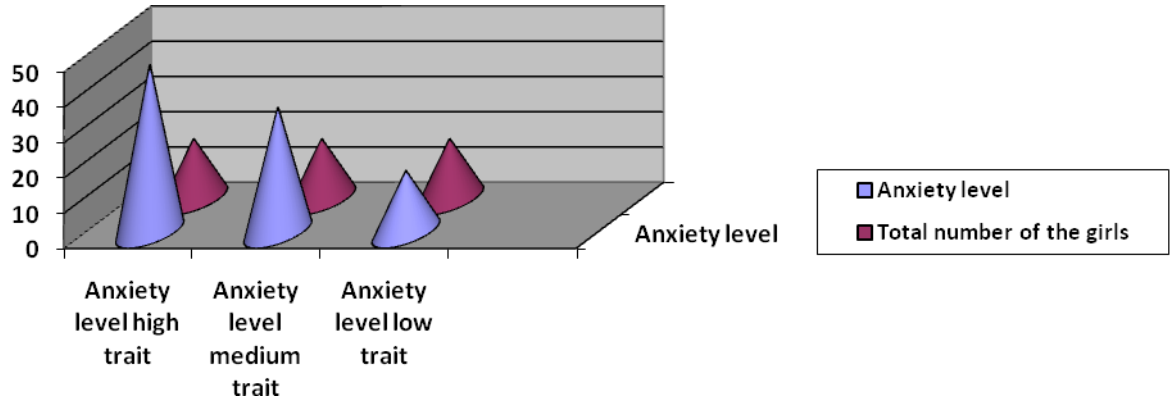


Chart 1 Anxiety level

8.2. Interpretation of anxiety test results in order to characterize the team

Given the distribution of scores on state anxiety level, we can say that most girls experience high anxiety under special conditions, respectively in competitive conditions. This form of anxiety can have the following effects:

- Major shortcomings in breathing control;
- The imaginative visualization can be distorted;
- Progressive muscle relaxation is not performed properly;
- Consciously asks for certain techniques of cognitive restructuring and control of maladaptive thoughts.

8.3. CASE STUDY

Sports woman S1

Anthropometric data: Age 18 years old, Height 1.68 m, Weight 64 Kg

Initial biomechanical evaluation in the laboratory of the S1 sportswoman, for the hit with the oina bat

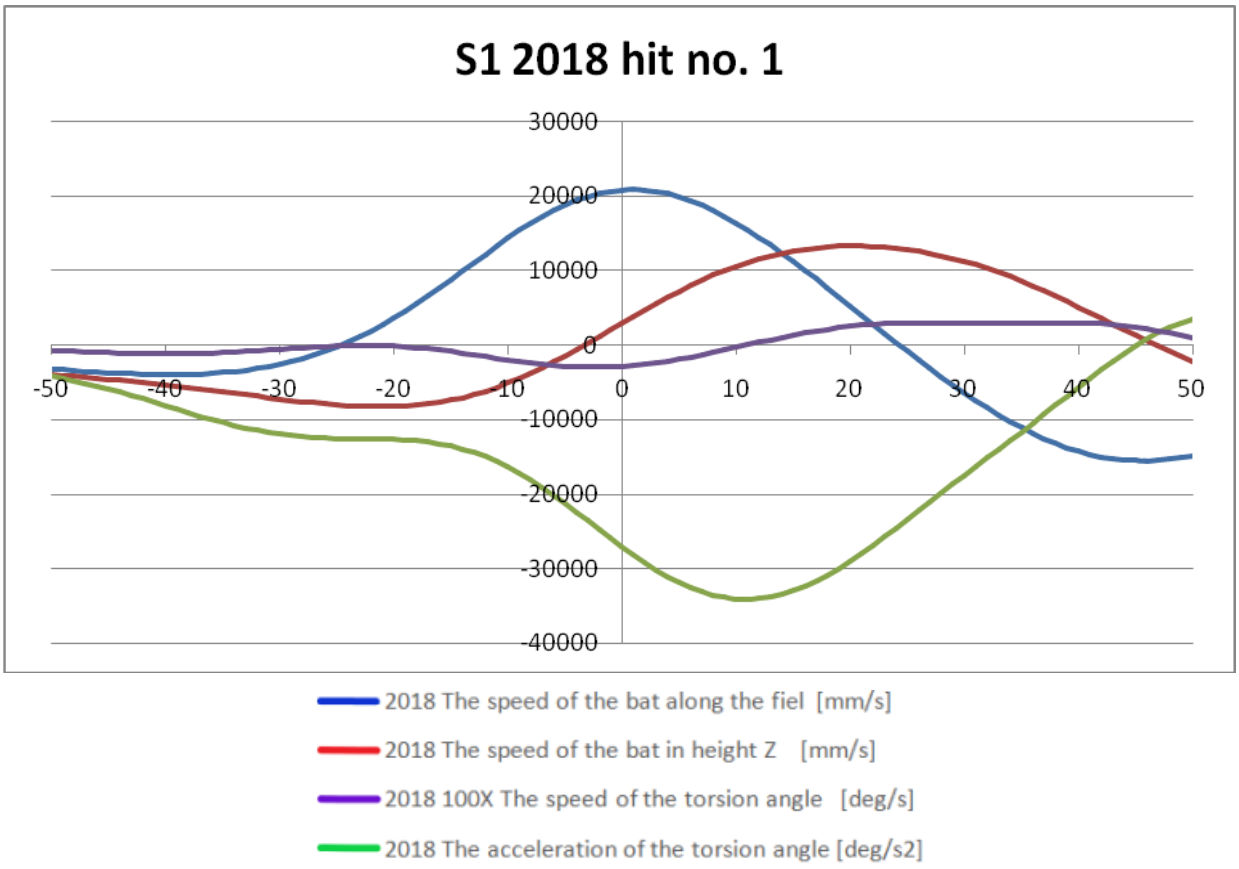


Fig. 18 The results of the measurement of the no.1 hit, performed in the S1 sportswoman's laboratory, before participating in the specific training: the variation of the speed of the bat tip along the field (blue curve), on height (red curve) and the kinematic parameters of the torsion angle of the S1 sportswoman.

It can be seen from the Figure. above that the maximum moments of the speed of the bat (at a point where it hits the oina ball), along the field (blue curve) and in vertical direction (red curve) are offset. The extreme moment of the speed of the torsion angle (green curve) is before the maximum moment of the speed of the bat along the field (blue curve). These parameters influence the trajectory of the ball on the field, which plays an important role in obtaining the extra points that are necessary in the evolution of the game when the team evolves "at bat".

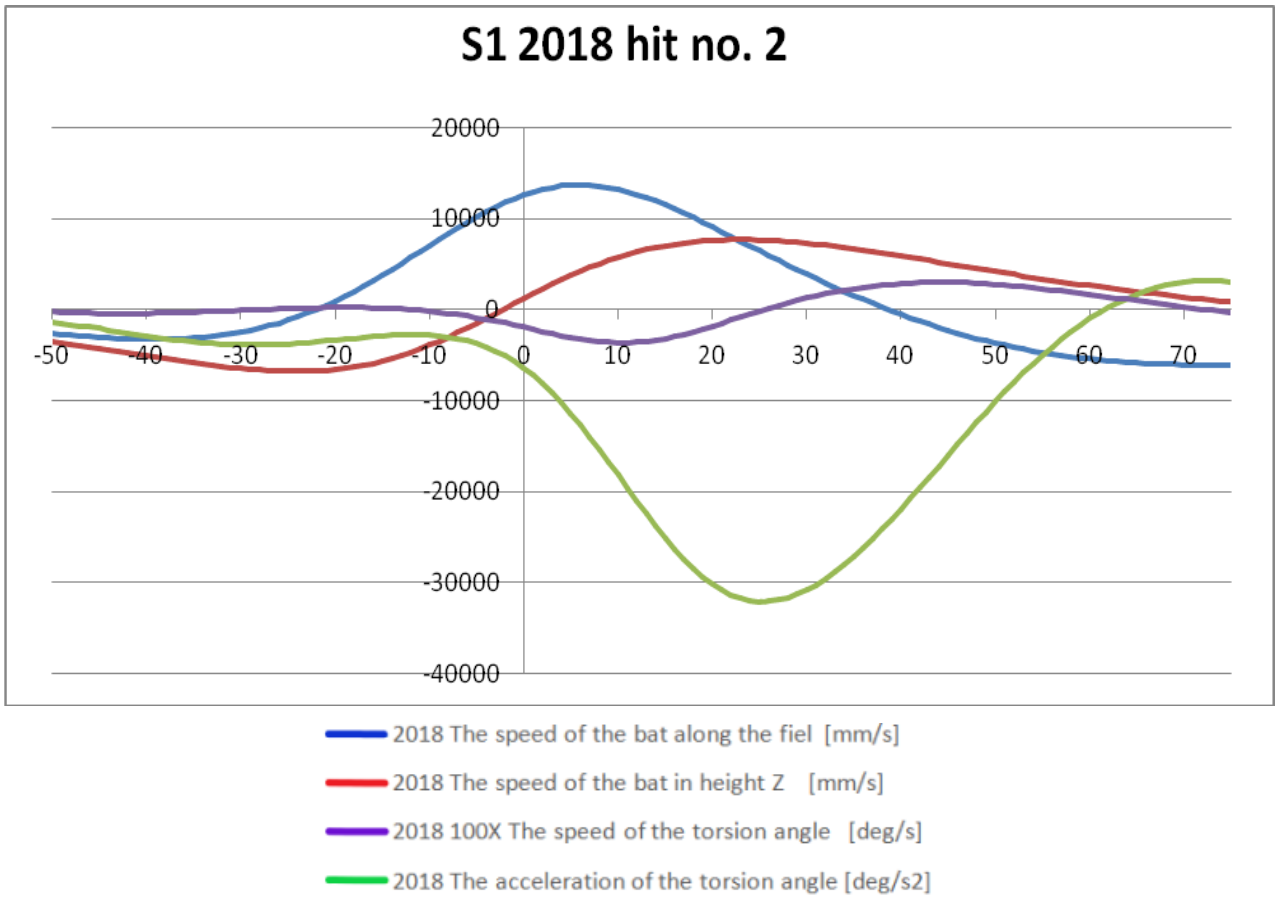


Fig. 19 The results of the measurement of hit no. 2, made in the S1 sportswoman's laboratory, before participating in the specific training: variation of the speed of the bat tip along the field (blue curve), on height (red curve) and kinematic parameters of the torsion angle of the S1 sportswoman.

It is observed at this hit, that the extreme moment of the speed of the torsion angle (green color curve) appears before the maximum moments of the speed of the bat (at a point where it hits the oina ball), along the field (the blue curve) and vertically (the red curve). At the same time, they are offset between them and the two maximum moments of the speeds of the tip of the bat.

Specific training programme for the S1 sportswoman

The S1 sportswoman evolves the last one at the batting, in the position number 11, in the order established by the regulation, having a great concentration power. Therefore, in the specific training programme for this sportswoman, a greater precision of the hit with the bat of the oina

ball placed on the support (placed on the sportswoman's axis of symmetry) was insisted on, at a fixed height, based on the anthropometric criteria. This programme led to a sportswoman's habit of hitting the ball in the perpendicular position of the bat on the axis of the shoulders. In this position, the maximum velocity of the bat tip appears on the two axes: vertical and horizontal. In order to obtain the temporal coincidence of the speed of the bat tip with the speed of the torsion angle of the sportswoman, the general training programme described above was followed.

Evaluation of the S1 sportswoman, for the hit with the oina bat

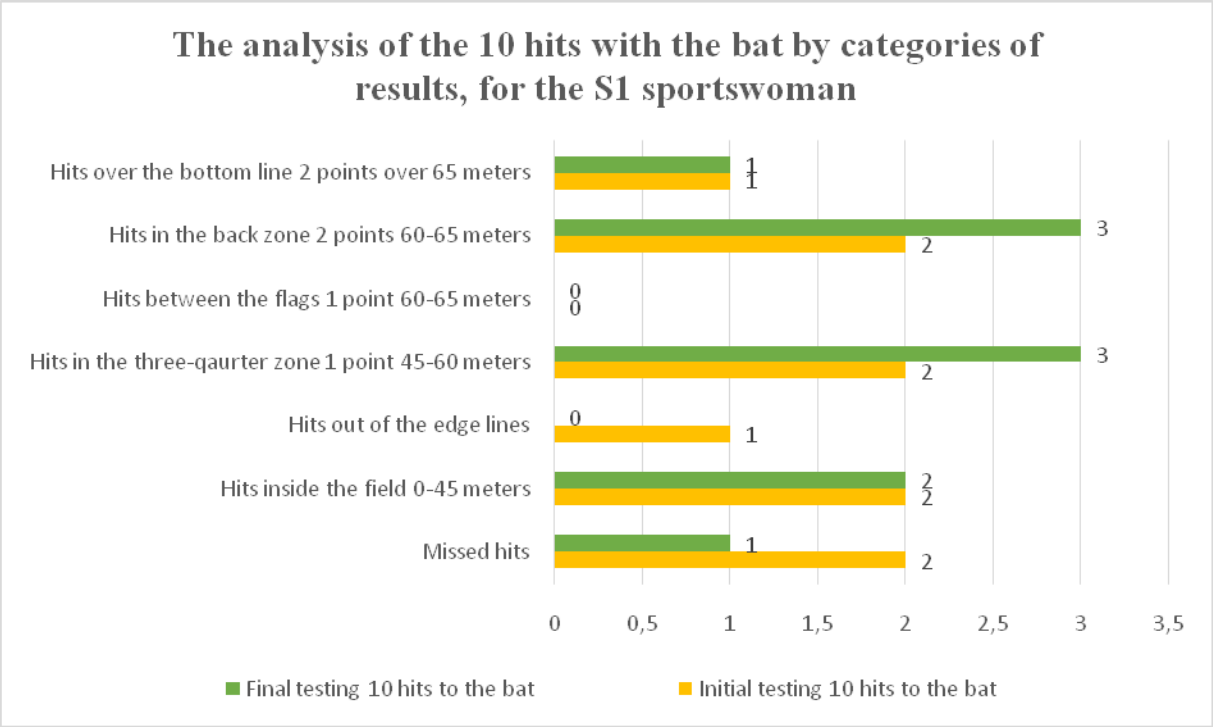


Fig.20 Comparative analysis of the hits with the bat, made in the field by the S1 sportswoman, at the initial and final testing (after participating in the specific training)

There is an improvement of the batting with the bat by 10% for the hits in the three-quarter zone hits in the 45-60m area, which bring 1 additional point compared to the initial test and with 10% for the back zone (hits in the area 60-65m, which bring 2 additional points) compared to the initial test.

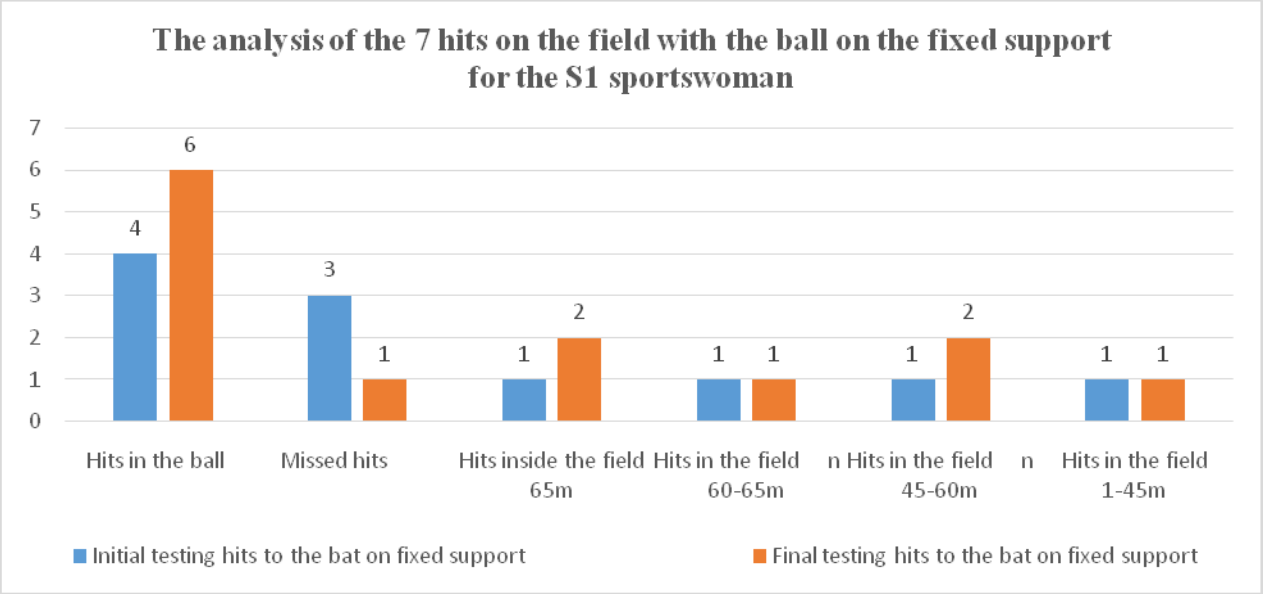


Fig. 21 Comparative analysis by types of hits, performed in the pitch by the S1 sportswoman, at the initial and final testing (after participating in the specific training), with the ball seated on a fixed support

It is observed in the S1 sportswoman, after training, an improvement by 14% of the strikes in the three-quarter zone (strikes in the area 45-60m, which bring 1 additional point) compared to the initial testing and by 14% over the back zone (strikes over 65m, which bring 2 additional points) compared to the initial test.

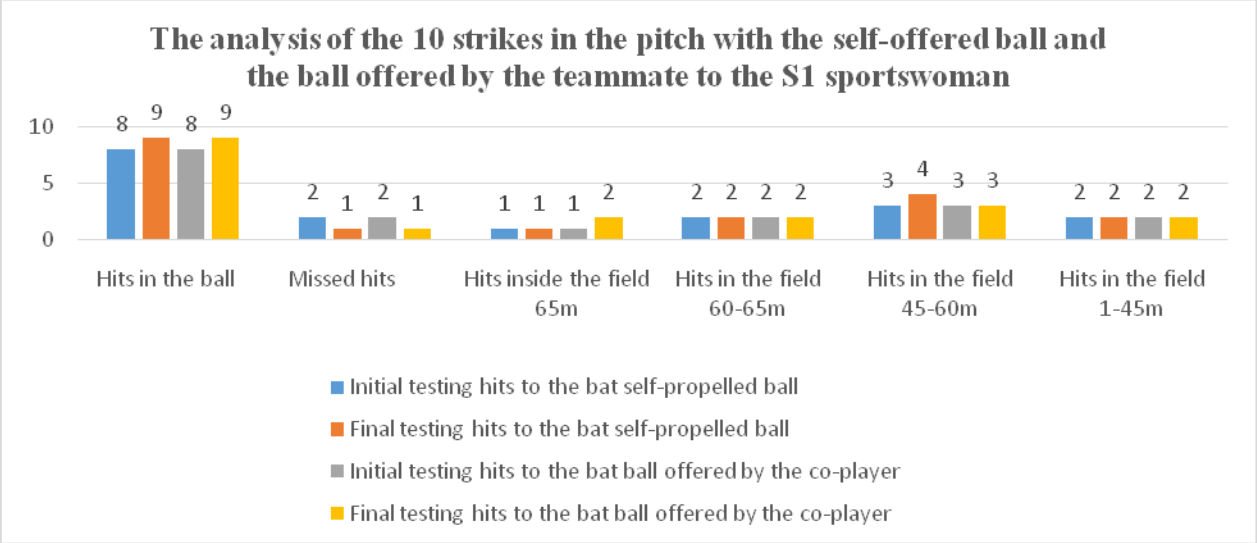


***Fig.*22** Comparative analysis by types of strikes, performed in the pitch by the S1 sportswoman, at the initial and final testing (after participating in the specific training), with the self-offered ball and the one offered by the teammate

It is observed in the S1 sportswoman, after the training, that the number of missed hits decreased, compared to the initial test, and it increased the hits in the three-quarter zone by 10% (hits in the 45-60m zone, which bring 1 additional point) compared to initial testing. Having a consistency in the 2-point hits, which determines the establishment of the place that she will occupy when the team evolves "at bat", depending on the position duties.

The final biomechanical evaluation in the laboratory of the S1 sportswoman, for the hit with the oina bat

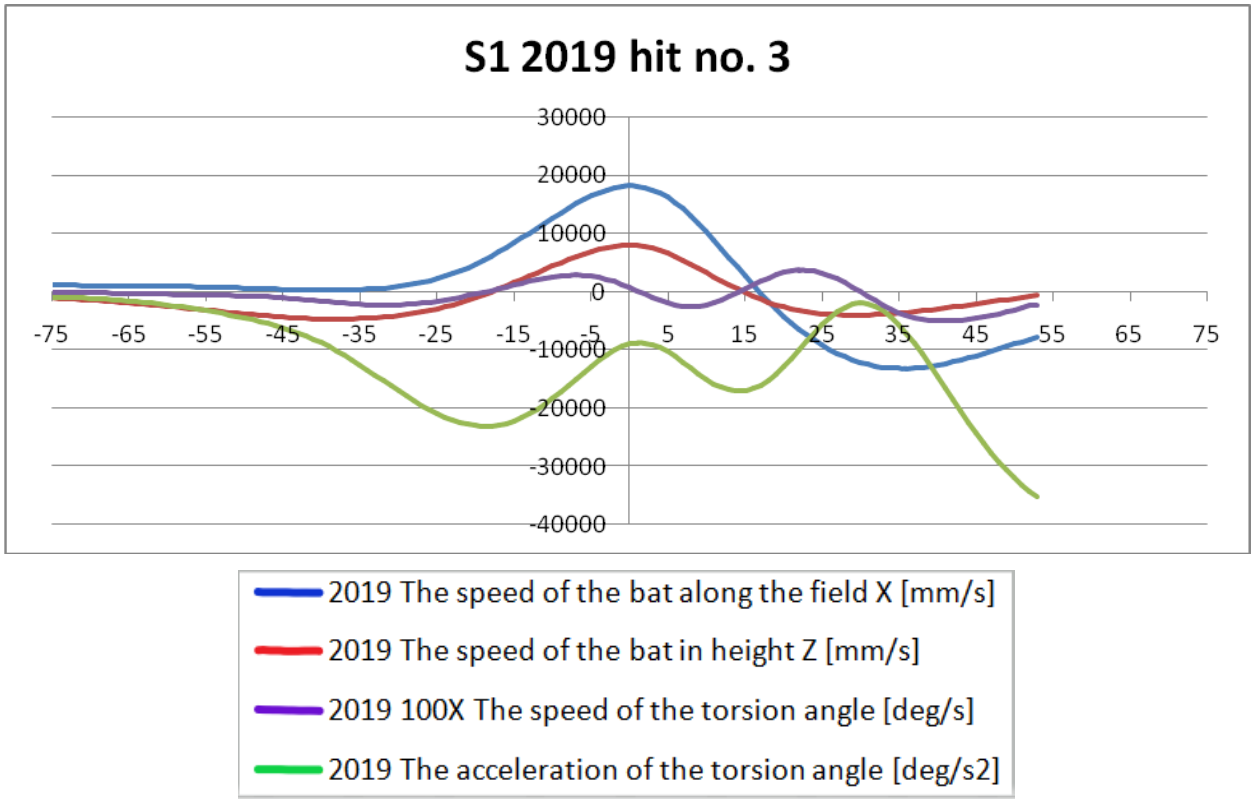


Fig.23 The results of the measurement of hit no.3, made in the S1 sportsman's laboratory, after participating in the specific training: the variation of the speed of the bat tip along the field (blue curve), on the height (red curve) and the kinematic parameters of the torsion angle of the S1 sportswoman.

It can be seen in hit no.3, that the two maximum moments of the speed of the bat (at a point where it hits the oina ball), along the field (blue curve) and in vertical direction (red curve), coincide with the extreme moment of the torsion angle speed (green color curve).

The temporal coincidence of the speed of the bat tip with the speed of the torsion angle of the sporstwoman was obtained based on the general training programme described above.

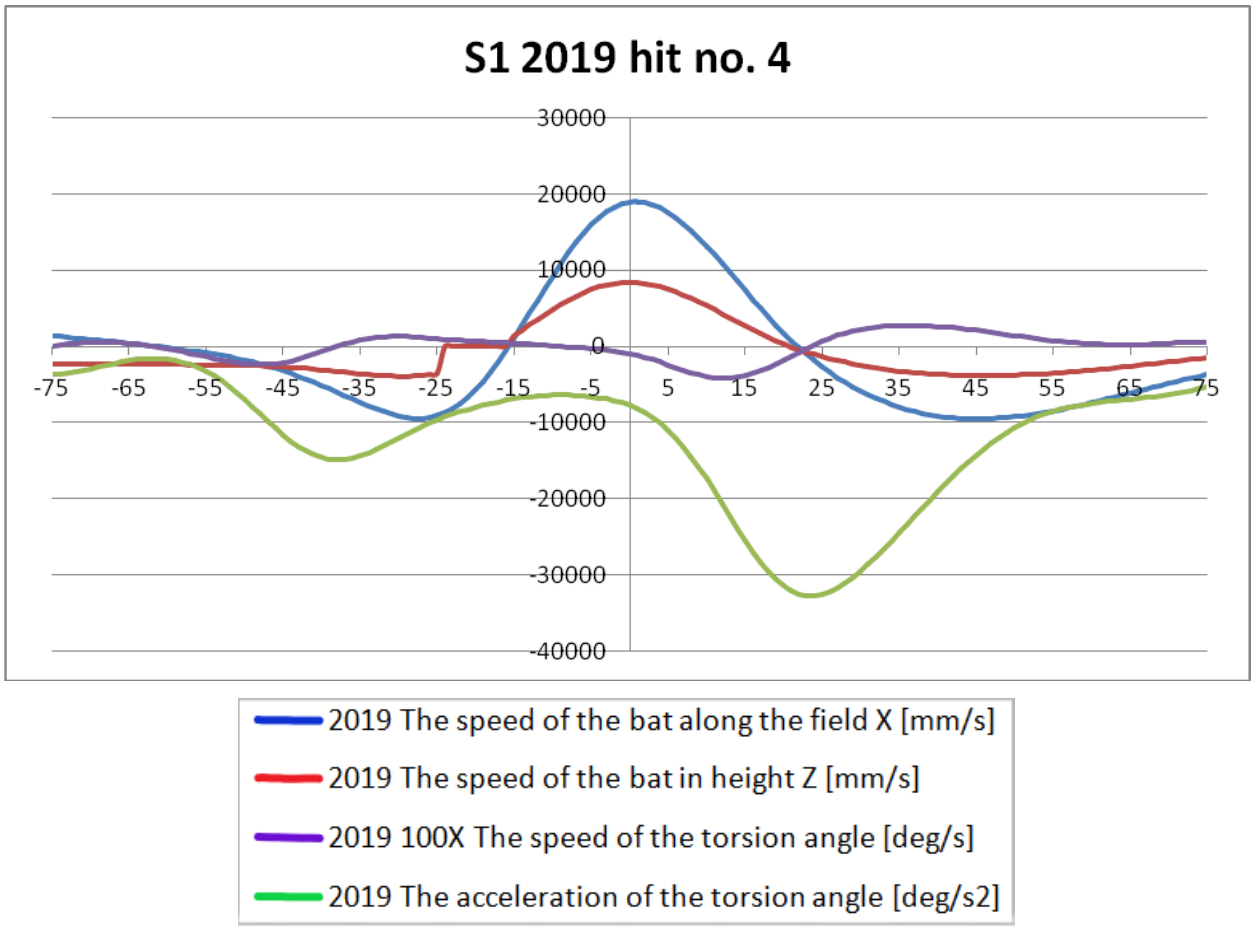


Fig. 24 The results of the measurement of hit no.4, realized in the laboratory of the S1 sportswoman, after participating in the specific training: the variation of the speed of the bat tip along the field (blue curve), on the height (red curve) and the kinematic parameters of the torsion angle of the S1 sportswoman.

It is observed from the previous imagine, that the maximum moments of the speed of the bat (at a point where it hits the oina ball), along the field (blue curve) and in vertical direction (red curve), coincide. The extreme moment of the speed of the torsion angle (green color curve) is almost coincident with the maximum moments of the speed of the bat, with a slight difference in advance, of 5 frames (0.02 s).

In the first test of the batting with the oina bat (initial) on the field of June I, from balls offered by the teammate, self-offered, batted from the fixed support, there were recorded 629 of battings, 37 for each subject, where there were 208 hits to score, 173 from the field, 29 from outside the line and 219 were missed (410 when the bat hit the ball and 219 failed to hit it.).

At the final test, there were 629 hits, 37 for each subject, where there were 355 hits to score points, 172 hits in the field, 12 hits outside the sidelines, and 90 missed hits (539 hits in which the bat hit the ball and 90 in which it did not hit), with a 70% progress on hit points. Subjects had a much more accurate hit mechanic biomechanics, being much more accurate in batting, managing to gain much easier points.

We were able to determine what methodical indications can be used during the workouts knowing that the angular velocity at the right arm is higher than the left one and that the angular velocity of the left elbow is greater than the right elbow, imposing the development of a muscular force of explosive type on the level of the right arm and left forearm, but also a programme of muscular training in which the emphasis must be placed on the development of the isometric type force, which will allow stabilization of the upper left limb and the right forearm.

It was chosen to record the variation of the acceleration and the speed of the torsion angle to see which methodical indication is more correct to determine the point on the bat where it hits the oina ball, specifying the position where the horizontal speed and the vertical speed of the bat are simultaneously maximum.

It is advisable to hit the ball when the tip of the bat has the maximum speed and not when it decelerates executing a correct movement from the biomechanical point of view, in this way we have a greater force of hitting the ball correlated with a better precision. The graphical recordings made show that the equipment used in the analysis of biomechanical movements is efficient, the subjects being able to make a progress that cannot be observed with the naked eye.
Seeing that the hit with the oina bat has a very short run time, I have been following the key moments since the bat leaves to hit the ball, the moment of impact with the ball and its deceleration. This helps us correct the executions to increase the efficiency of the hits with the bat, implicitly the efficiency of the points obtained. We can thus develop the explosive force that will support a batting as efficiently as possible.

All the conclusions presented above justify us to say that the biomechanical analysis and the type of training developed and experienced by us have been validated and can be applied by sportsmen to perform the hit with the oina bat.

These results were reflected in the 2019 competitive year, when the women's team of the C.S.M. ProgressBăilești won the National Championships of Romania in June I from Căseiu Cluj-Napoca and seniors from Horia - Constanța.

8.4 Initial and final results at batting with an empty bat for 30 seconds and at wall hits, with 1 kg medicine ball made in 30 seconds.

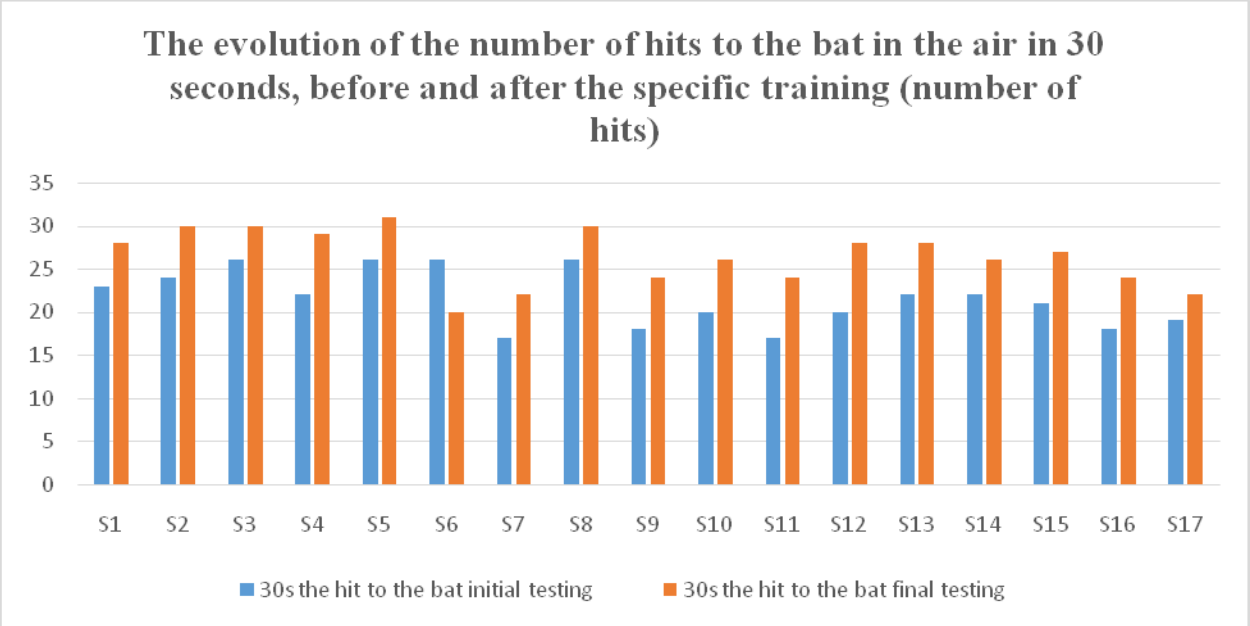


Fig. 25 The evolution of the numbers of hits with the bat performed in the air in 30 seconds

I tested the subjects to observe their execution speed in the beat with the walking stick, empty for 30 seconds. Compared to the first test, an improvement of the execution techniques was observed. The athletes had the biomechanics in the battle with the more accurate foot stick, but also a higher execution speed. The progress made by sportsmen between 15 and 40%, with the exception of the S6 sportswoman who has a setback, because the beating with the empty baton was made from the spot, being left-handed, she cannot take the step added.

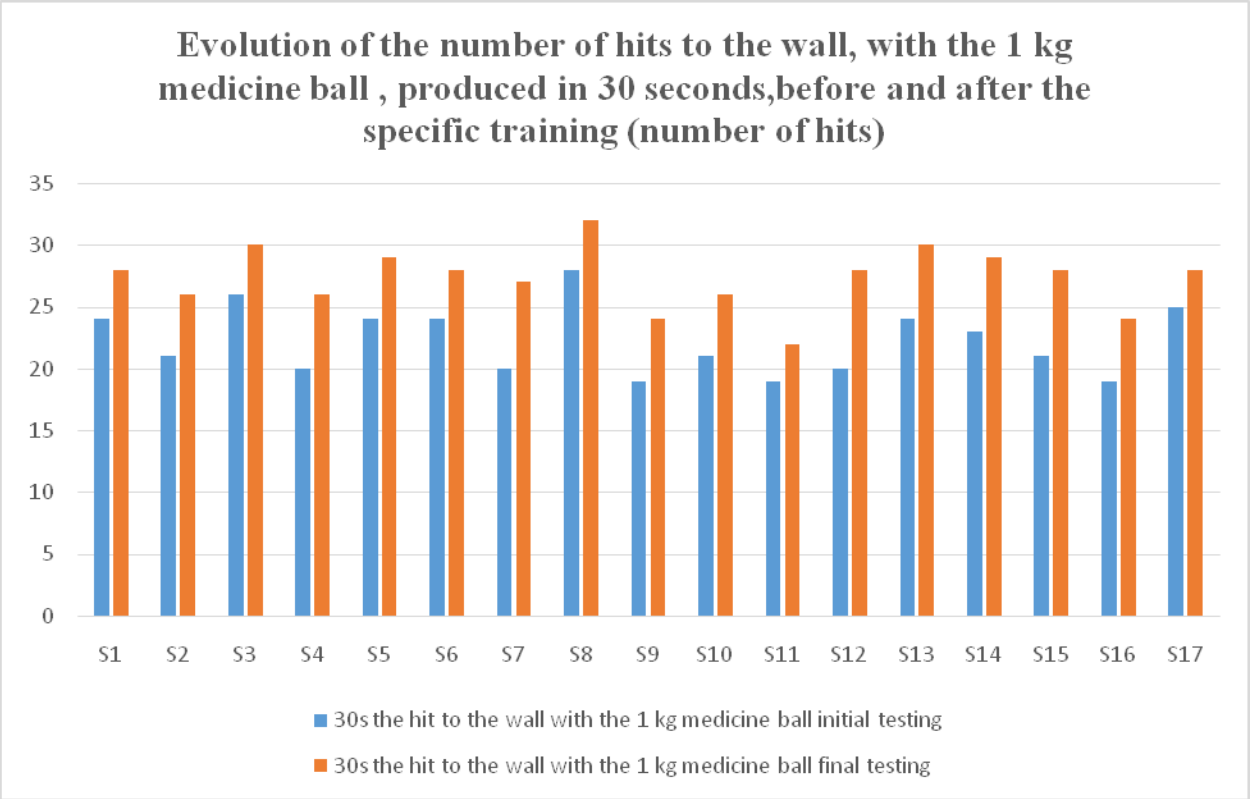


Fig. 26 The evolution no. of hits to the wall, with the medicine ball of 1 kg, realized in 30 seconds.

We tested the sportsmen to develop their explosive force in the batting with the oina bat, using the medicine ball on the wall for 30 seconds. The sportsmen had a much better evolution after the specific training. The progress made by sportsmen is shown in figure. 26, each having an improvement between 12 and 40%.

CHAPTER IX
CONCLUSIONS OF THE EXPERIMENTAL RESEARCH

In order to keep up with the evolution of sports performance in the oina game, we must know the elements that generate or limit a progress in its evolution. With the help of the biomechanics, specialists can identify new elements that prevent certain deficiencies that appear during the hit with the oina ball, improving the training methodology by correctly using the parameters that play a role in the batting of the ball.

In order to carry out efficient bats, we must have a physical training that optimizes the factors of the sports training to make the difference, to win the game. The evaluation of the physical training of the sportsmen must be performed periodically through tests and control tests. Thus, we designed / elaborated the samples from the final experiment, taking into account the physiological characteristics to determine the type of exercise according to the ability of each spotrsman to respond to the training demands and the peculiarities of the role in the oina game.

The modernization of the investigation equipment and the training means correlated with the interdisciplinary collaboration of the specialists can bring great benefits to the development of the oina game.

As a result of the study, based on the results obtained, we can say that the torsion angle of the trunk is a biomechanical parameter with which we can improve the speed of the bat tip during the hit correlated with a training programme for sportsmen to hit the bat in order to gain points, which can bring victory.

In the research activity we used information obtained from studying the few specialized documents, some materials regarding the training of oina players, but also comparison with other sports that use the bat to hit the ball. These helped us to better understand the parameters that influence the batting.

Performing some measurements and comparative analysis of the values of speed and acceleration of the torsion angle during the hit with the oina bat have shown us the correlation that exists between them and the speed of the tip of the bat, determining that we recommend to the coaches more attention in the training of batting with the bat.

The design and elaboration of the training project of the batting with the oina bat have been the subject of a pedagogical experiment being carried out in full accordance with the

training standards specific to the training, based on a set of general and specific objectives, but also complex structures of exercises specific to the oina game, with direct reference to the batting with a bat, with direct effect on the torsion angle of the trunk.

As observed in all the frames in the graphs, the torsion angle accelerations have values close to zero, so the speeds of this angle have maximum values and coincide or almost coincide with the maximum moments of the bat speed in the direction of the field (red curve) and in the vertical direction (blue curve), thus having a good synchronization resulting from the workouts.

9.1. Limitations and own contributions to the research

Limitations - The purpose and objectives of the research were stopped at the level of a case study on the SCM ProgresulBăilești team, so the results cannot be generalized, but in order to have a wider effect this programme can be applied on several teams at national level. A limitation of our research is given by the few sources of documentation that aim at training under all aspects of the oina players.

Contributions - The actuality and the necessity of the approached topic has determined us to use scientific research equipment at the highest level of performance in the oina game, thus contributing to the enrichment of the research in the field of Sport.

A personal contribution is the elaboration of the work programmes in the batting with the bat, these being realized as a result of the complex laboratory evaluations. We consider this approach a useful one in our field, offering the possibility to other coaches to put this into practice.

The creation of an algorithm for biomechanical analysis of the upper limb and the trunk in the oina game opens the way to conduct extensive research, which will allow a training based on scientific evidence in the oina game.

The elaboration of control samples is an element of novelty brought by this research.

Recommendations

As a result of the measurements and analyzes carried out, as well as the conclusions drawn from the research activity carried out, we propose:

- Awareness of the sportsmen that they must hit the ball with the oina bat when it has the maximum speed on both the horizontal axis and the vertical axis at an angle of 40-45 degrees;

- The connection between the velocity of the bat tip, the speed of the torsion angle and the length of the hit is materialized by the number of points obtained from the hit with the oina bat;
- Organizing trainings in order to correlate the biomechanics of the bats with the tasks of each sportsman, depending on the number that he occupies when performing the batting;
- Use during the training by as many sportsmen as possible of the successfully experienced training, representing a starting base, in the preparation of hitting the ball with the oina bat in the performance teams;
- Development of a methodical guidance for the batting with the oina bat training project and the extension of the biomechanical analysis for other technical elements.

BIBLIOGRAPHY

Adair, R. (2002). *The physics of baseball.* New York: Harper.

Agmaval, G. C., Gottlieb, G. L. (1984). Mathematical model- ing and simulation of the postural control loop-part II. *CRC Crit, Rev, Biomed, Eng, 11, 113-154.*

Andrew, M. C. (2006). *Oxford Dictionary of Psychology*. Editura Oxford University Press, p. 283.

Arakawa, K. (2014). Oblique Impact Analysis of a Golf Ball *Applied Mechanics and Materials Trans Tech Publications, Switzerland 566, 443-8*

Avramescu, T. E. (2013). *The anatomical basis of movement*. available from: cis01.central.ucv.ro/ educatie_fizica-kineto/pdf/.../carte_anatomie_LP.pdf

Bahill, A.T., and LaRitz, T. (1984). Why can't batters keep their eyes on the ball? *American Scientist, 72, 249–253*

Bahill, A.T., Karnavas, W. (1991). *"The ideal baseball bat". New Scientist, vol. 130, no. 1763, pp. 26–31*

Bahill, A.T., Freitas, M. (1995). Two methods for recommending bat weights. *Annals of Biomedical Engineering, 23(4), 436–444.*

Bahill, A.T. (2004). The ideal moment of inertia for a baseball or softball bat. *IEEE Transactions on Systems, Man, and Cybernetics - Part A Systems and Humans, 34(2), 197–204.*

Baker, D., Mercer, J., & Bittinger, M. (1993). *You can teach hitting*. Carmel: Bittinger Books.,Inc., Carmel, IN.

Baldwin, D.G., Bahill, A.T. (2004). A model of the bat's vertical sweetness gradient, The Engineering of Sport 5, M. Hubbard, R., D. Mehta, and J.M., Pallis, (Eds.), *Proceedings of the 5th International Engineering of Sport Conference, September 13–16, 2004,* Davis, CA, *International Sports Engineering Association (ISEA), Sheffield, UK, Vol. 2, 305–311.*

Barlow, D. H. (1988). Anxiety and its disorders: The nature and treatment of anxiety and panic. *New York: Guilford Press.*

Barlow, D. H. (2000). Unraveling the mystery of anxiety and its disorders from the perspective of emotion theory. *American Psychologist, 2000, 1247-1263.*

Barnes, L., Harp, D., Jung, W.S. (2002). Reliability generalization of scores on the Spielberger State-Trait Anxiety Inventory. *Educational and Psychological Measurement, 62(4), 603-618.*

Bodo, R., Reinhard, K., Dimitris, M., (eds.) (2007). Human Motion - Understanding, Modelling, Capture and Animation. Volume 36 in *Computational Imaging and Vision*, Springer, Dordrecht.

Bompa, T. (2003).*Performance in sportsgames. Trening theory and methodology*, Bucureşti: Publishing house Ex Ponto,

Botez, D. (1957).*The joy of youth*. Bucureşti: Publishing house Tineretului, p.13.

Briggs, L. (1945). Methods for Mesuring the Coefficient of Restitution and the Spin of a Ball. *Nat. Bur.Standard Research Paper RP162434 1-24*

Buiac, D., Buleu, A. (2005). *Oina –The perfect game*. Bucureşti: Publishing house Profexim, p.12.

Buiac, D. (2018). *The small child needs exercise and play movement,* Bucureşti: Publishing house Eikon, p.83.

Budescu, E. (2013).*General Biomechanics* Iași https://mec.tuiasi.ro/ diverse/ Biomecanica_ gen. pdf

Costescu, G. (1926). Oina our. *In the bulletin O.N.E.F. Nr.6, an IV, p.81.*

Crisco, J.J., Greenwald, R.M., și Penna, L.H. (1999). Baseball bat Performance: A Batting Cage Study. *[Online]*. Available: http://www.nisss.org/BBSPEED6a.html.

Cristophe, A., Legeron, P. (2001). *How to free ourselves from the fear of others. Thrush, shyness, inhibitions and social phobia*. Bucureşti: : Publishing house Trei.

Cross, R. (1999). Impact of a ball with a bat or racket. *Am., J. Phys., 67, 692– 702.*

Cross, R. (2008). *Mechanics of swinging a bat*. Department of Physics, University of Sydney, Sydney NSW 2006, Australia.

Daniel, A., Russell, Ph., D. (2005). *How are Baseball and Softball Bats Different?* www.acs. psu.edu/drussell/bats/baseball-softball.html.

David, M., Fortenbaugh (2011). *The biomechanics of the baseball swing,* p.1. https://scholarlyrepository.miami.edu/oa_dissertations

Davila, Al. (1956). *Vlaicu Vodă*. București: : Publishing house E.S.P.L.A., p.46.

DeRenne, C. (1993). *High-tech hitting: science vs. tradition*. St. Paul: West.Pub.Co.

Dong, H., and Moys, M. H. (2006). Experimental study of oblique impacts with initial spin *Powder Tech.161 22 – 31*

Dragnea, A, Mate-Teodoresc, S. (2002). *Sport theory*. Bucureşti: : Publishing house FEST.

Kagan, D., and Atkinson, D. (2004). The Coefficient of Restitution of Baseballs as a Function of Relative Humidity. *The Phy.Teacher 42 89-92*

Eggeman, G.W.& Noble, M.L. (1982). Measurement System for the Determination of Hand Grip Forces During a Baseball Bat Swing. *In Proceedings of the ASME WAM, 82-DET-49, ASME, New York, NY, pp. 1-5.*

Epuran, M. (1992). *Research methodology of body activities* vol. I, II, Bucureşti: A.N.E.F.S, 246 p.

Epuran, M., Holdevici, I., Toniţa, F. (2001). *Psychology of performance sports: theory and practice* Bucureşti: Publishing house FEST.

Escamilla, R.F., Fleisig, G.F., DeRenne, C., Taylor, M.K., Moorman, III, C.T., Imamura, R., Barakatt, E., Andrews, J.R. (2009). Effects of bat grip on baseball hitting kinematics. *Journal of Applied Biomechanics, 25(3), 203-209.*

Escamilla, R.F., Fleisig, G.F., DeRenne, C., Taylor, M.K., Moorman, III, C.T., Imamura, R., Barakatt, E., Andrews, J.R. (2009*). A comparison of age level on baseball hitting kinematics. Journal of Applied Biomechanics, 25(3), 210-218.*

Federația Română de Oină (1967). *Sheep section schedule.* Bucureşti: Publishing house Uniunii de Cultură - fizică și sport.

Fenn, W. O.,Marsh,B. S.(1935). Muscular force at different speeds of shortening. *J. Physiol, 85, 277-297.*

Fleisig, G. S., Hsu, W. K., Fortenbaugh, D., Cordover, A., & Press, J. M. (2013). Trunk axial rotation in baseball pitching and batting. *Sports Biomechanics, 12, 324–333.*10.1080/14763141.2013.838693 [Taylor & Francis Online], [Web of Science ®], [Google Scholar]

Fleisig, G.S., Zheng, N., Stodden, D.F., Andrews, J.R. (2002). Relationship between bat mass properties and bat velocity. *Sports Engineering, 5, 1–8.*

Gagea, A. (2010). *Tratat de cercetare științifică în educație fizică și sport*. București: Discobolul, p.300.

Gola, M., & Monteleone, J. (2001). The complete book of hitting faults and fixes. *New York, McGraw-Hill.*

Gwynn, T. (1998). The art of hitting. *New York, GT.*

Lau, C., & Glossbrenner, A. (1984). The winning hitter: How to play championship baseball. *New York, Hearst.*

Hanin,Yuri, L. (2003).Performance Related Emotional States in Sport: A Qualitative Analysis 48 paragraphs Forum Qualitative Sozialforschung. *Forum: Qualitative Sozial Research,4(1), Art.5.*

Hennessey, W.J., Johnson, E.W. (2000). Lower limb orthoses. *In: Physical Medicine and Rehabilitation. 2nd ed. Philadelphia, Pa: WB Saunders Co; 2000: 326-52*

Hirano, Y. (1986). Biomechanical analysis of baseball hitting. *Paper presented at the International Symposium on Biomechanics in Sports. Halifax, Nova Scotia, Canada.*

Hill, A. V. (1938). The heat of shortening and dynamic constraints of muscle. *Proc., Roy., Soc., Lond., 126B:136-195.*

Holdevici, I.(1998).*Psychotherapy for anxiety disorders*. Bucureşti: Publishing house Ceres.

Iliescu, A., Gavrilescu, D. (1976). *Functional anatomy and biomechanics* București: Publishing house Sport-Turism, p.127.

Iorga, N. (1940). *Banat observations and problems*. București: Publishing house București, p. 82.

Jones, J.G.,& Hardy, L. (1993). Stress and cognitive functioning in sport. *Journal of Sport Science*, 7, 41-63.

Kazumichi, Ae.,Sekiya, K. (2015). Kinetic analysis of the upper limbs in baseball tee-batting under low hitting point height condition *International Conference on Biomechanics in Sports. Poitiers, France, June 29 - July 3.*

Kazumichi, Ae.,Sekiya, K., Norihisa, F., Michiyoshi, Ae.(2017). A simulation analysis on effects of the upper body motion on bat-head speed in baseball batting *35th.Conference of the International Society of Biomechanics in Sports, Cologne, Germany, June 14-18.*

Kazumichi, Ae.,Sekiya, K., Norihisa, F., Michiyoshi, Ae.&Takashi, K. (2017).Kinetic analysis of the lower limbs in baseball tee batting. *Journal Sports Biomechanics Pages 283-296* https://www.tandfonline.com/doi/abs/10.1080/14763141.2017.1284257

Kennedy, BL., Schwab, J.J., Morris, R.L., Belida, G. (2001). Assessment of state and trait of anxiety in subjects with anxiety and depressive disorders. *Psychiatric Quarterly, 72: 263-276.*

Kirițescu, C. (1964). *Palestrica*. București: Editura Uniunii de Cultură Fizică și Sport, p.519.

Koenig, K., Mitchell, N.D., Hannigan, T.E., and Clutter, J.K. (2004). The influence of moment of inertia on baseball/softball bat swing speed. *Sports Engineering, 7(2): 105-117.*

Koike, S., Mimura, K. (2016). Effective timing of exerting joint torques to obtain baseball bat head speed. *Proceeding of the 34th International Conference on Biomechanics in Sports.* Tsukuba, University of Tsukuba.

Kompier, M. (2003). Job Design and Well-Being. In M. J. Schabracq, J. A. M. Winnubst, & C. L. Cooper (Eds.), The Handbook of Work and Health *Psychology (pp. 429-455).* Chichester: John Wiley & Sons, LTD.

Knudson, D. (2003). Introduction to Biomechanics of Human Movement. *In: Fundamentals of Biomechanics. Springer, Boston, MA*

Lambrior, A. (1876). Romanian customs and beliefs. *Convorbiri literare, nr. IX din 1din Aprilie 1875 - 1 Martie.*

Maeda, M. (2003). The effects of the characteristics of baseball bats on swing. *Journal of Japan Society of Sports Industry, 13(1), 45-51, (în Japonia).*

Magdaș, A. (2005). *All about the games oina*. Baia Mare: Publishing house Maria Montessori, p.81.

Marin, M., Văduva, C., Rusu, M.R., Rusu, L. (2019). Experimental determination of the coefficient of restitution. *IOP Conf. Series: Materials Science and Engineering 572,* 012103 doi:10.1088/1757-899X/572/1/ 012103

Martens, R., Vealey, R.S. & Burton, D. (1990). *Competitive anxiety in sport*. Champaign, IL: Human Kinetics.

Merriaux P, Dupuis Y, Boutteau R. (2017). A study of vicon system positioning performance. *Sensors (Switzerland) (2017) 17(7)*

Messier, S.P., Owen M.G. (1985). The Mechanics of Batting: Analysis of Ground Reaction Forces and Selected Lower Extremity Kinematics. *Res., Quart., 56(2),138 −143.*

Moje, C., Frangulea, S., Roată, R., Şiclovan, L. (2011). *Rediscover and learn our national sport oina.* Constanța: Publishing house Muntenia, , p.15.

Nathan, A. M. (2000). Dynamics of the baseball-bat collision. *Am., J. Phys., 68, 979-990.*

Nathan, A.M. (2003). Characterizing the performance of baseball-bats. *American Journal of Physics, 71, 134–143.*

Nathan, A.M., Russell, D.A., and Smith, L.V. (2004). The physics of the trampoline effect in baseball and softball bats. *Proceedings of the 5th Conference of Engineering of Sport*, M. Hubbard, R.D., Mehta, and J.M., Pallis (Eds.), *International Sports Engineering Association (ISEA), Vol. 2, 38–44.*

Nathan, A.M., Hopkins, J., Chong, L., and Kaczmarski, H. (2006). The effect of spin on the flight of a baseball. *SABR conference, Seattle, June.*

Naser, B., Mahmood, S.,, Leyla, S. R. & Zahra, H. A. (2013). The relationship between coaching behaviors and competitive anxiety in Golestan Province Futsal super league player. *European Journal of Experimental Biology*, 3(2) 383-386.

Nuţ, S. (2003). *Anxiety and performance in young people* Timişoara: Publishing house Eurostampa.

Papilian, V. (1982). *Human anatomy* Volumul I, Aparatul locomotor, București: Publishing house Didactică și Pedagogică.

Pădureanu, D.I. (1989). *Historic store. XXIII,1/ p. 60.*

Persson, J. (2012). Measure the coefficient of restitution for sports balls. *Phy.Ed.11 662-3*

Plehn, K., Peterson, R. A. (2002). Anxiety sensitivity as a predictor of the development of panic symptoms, panic attacks, and panic disorder: A prospective study. *Journal of Anxiety Disorder, 16, 455–474.*

Postolache, N. (2009). *The fascination of the games oina is the game of Romanians everywhere* București: Publishing house Profexim, p. 39.

Postolache, N., Postolache, M. (1969). *Romanian sports traditions.* București: Publishing house Consiliul Național pentru educație Fizică și Sport, p.213.

Rafailescu, A. (1984). *Newsleter Federația Română de Oină*

Rafailescu, Al., și Oprițescu, C. (1974). *Oină*. București: Publishing house Stadion p. 7.

Rafailescu, Al., și Iancu, C. (1976). *Oina past and present*. București: Publishing house Sport turism p.10,16.

Regan, D. (2011). Visual factors in hitting and catching, *Journal of Sports Sciences* Publication details, including instructions for authors and subscription information: http://www.tandfonline.com/loi/rjsp20

Reiss, S., Peterson, R. A., Gursky, D. M., & McNally, R. J. (1986). *Anxiety sensitivity, anxiety frequency, and the prediction of fearfulness*. Behaviour Research and Therapy, 1–8.

Rivera, M., Leyva, WD., Archer, DC., Munger, CN., Watkins, CM., Wong, MA., Dobbs IJ., Galpin, AJ., Coburn, JW., Brown, LE. (2018). No Effect of Assisted Hip Rotation on Bat Velocity. Author informationHuman Performance Laboratory, Center for Sport Performance, Department of Kinesiology, California State University, Fullerton, CA, *IntJExercSci. 2018May1;11(4):68-74*
USAhttps://www.ncbi.nlm.nih.gov/pubmed/29795730

Roată, R. (2014). *Oina learning the game and preparing the representative team.* Suceava: Editura Universității " Ștefan cel Mare", p.13.

Roată, R . (2018). *Oina modeling the preparation of children and juniors.* Suceava: Publishing house Universității " Ștefan cel Mare", p.36. 56.

Roată, R. (2018). *Oina initiation into the oina game*. Suceava: Publishing house Universității " Ștefan cel Mare", p.40.

Robson, T. (2003). *The hitting edge*. Champaign: Human Kinetics.

Russell, D.A. (2004). Hoop frequency as a predictor of performance for softball bats. Proceedings of the 5th Conference of Engineering of Sport, M. Hubbard, R.D., Mehta, and J.M., Pallis, (Eds.), *International Sports Engineering Association (ISEA), Vol. 2, pp. 641–647,* See also http://www.kettering.edu=drussell=batsnew=sweetspot.html.

Rusu, L., Marin, M., Văduva, C., Dragomir, M. (2018). *Biomechanic assessment of shoulder stability in specific oina sport activity Congress F.S.P.A. Helsinki* accepted for a poster presentation at our congress Prevention.

Sawicki, G.S., Hubbard, M., and Stronge, W.J. (2003). How to hit home runs: Optimum baseball bat swing parameters for maximum range trajectories. *American Journal of Physics, 71(11), 1152–1162.*

Sawicki, G.S., Hubbard, M., and Stronge, W.J. (2004). Reply to comments on ''How to hit home runs: Optimum baseball bat swing parameters for maximum range trajectories''. *American Journal of Physics, 73(2), 185–189.*

Schaechter, J.D., Kraft, E., Hilliard, T., et al.(2002.) Motor recovery and cortical reorganization after constraint-induced movement therapy in stroke patients: a preliminary study. *Neurorehabil Neural Repair.16, 326–338*

Schmidt, N. B., Lerew, D. R., Jackson, R. J. (1997). The role of anxiety sensitivity in thepathogenesis of panic: Prospective evaluation of spontaneous panic attacks during acute stress. *Journal of Abnormal Psycholgy, 106, 355–364.*

Simion, Ghe., Mihăilă, I., Stănculescu G. (2011). *Sport training. Systemic concept*, Constanța: Publishing house University Press.

Shinebourne, P. (2011). Interpretative Phenomenological Analysis. In N. Frost (Ed.), Qualitative Research Methods in Psychology: Combining Core Approaches p. 44-65. Maidenhead: Open University Press.

Szymanski, D.J., Szymanski, J.M., Bradford, T.J., Schade, R.L. & Pascoe, D.D. (2007). Effect of twelve weeks of medicine ball training on high school baseball players. *Journal of Strength and Conditioning Research, 21(3), 894-901.*

Szymanski, D.J., McIntyre, J.S., Szymanski, J.M., Bradford, T.J., Schade, R.L., Madsen, N.H. & Pascoe, D.D. (2007). Effect of torso rotational strength on angular hip, angular shoulder, and linear bat velocities of high school baseball players. *Journal of Strength and Conditioning Research, 21(4), 1117-1125.*

Tago, T., Ae, M., & Koike, S. (2005). The trunk twist angle during baseball batting at the different hitting points. *Poster session presented at International Society for Biomechanics XXth Congress, Cleveland, OH.*

Tago, T., Ae, M., Fujii, N., Koike, S., Takahashi, K., Kawamura, T. (2006). Effects of height of hitting point on joint angular kinematics in baseball batting. *Japanese Journal of Biomechanics, 10(1), 2-13.*

Tago, T., Ae, M., Fujii, N., Koike, S., & Kawamura. T. (2006). Effects of inside and outside hitting point on joint angular kinematics in baseball batting. *Japanese Journal of Biomechanics, 10(4), 222-234.*

Tago,T., Kaneko, K., Tsuchioka, D., Ishii, N., Wada, T. (2016). Kinematic analysis of baseball batting motion when batting pitches with varying velocities. *34th International Conference on Biomechanics in Sports, Tsukuba, University of Tsukuba.*

Teodorescu, L., Bucur, C., Rafailescu, A. (1954). *Oina*. București: Publishing house Cultură Fizică și Sport, p.153.

Ursu, Gr. A. (2014). *Oina the traditional Romanian sport in the teleorman village of Crângu*. Cluj Napoca: Publishing house Eikon, P. 11.

Văduva, C., Gheorghiu G.E. (2019). *Oina in 6* Publishing house Maya Publishing ISBN 978-607-618-709-1.

Văduva, C**.,** Marin, M., Rusu, L. (2020). Biomechanic parameters analysis of trunk in oina game" - has been accepted for publication in Medicina Sportiva" - *Journal of the Romanian Sports Medicine Society,* issue of June, 2020.

Văduva, C., Monea, Ghe., Marin, M., Rusu, L. (2019). Analysis of stick shoting in oina game using the biomechanics parameters *International Proceedings of Human Motricity/ ICPESK 2019 Supplementary Issue of Discobolul – Physical Education, Sport and Kinetotherapy Journal p. 331-338*, https://doi.org/10.35189/iphm.icpesk.2019.50

Văduva, C., Monea Ghe., Marin M., Rusu L., (2020). The importance of the tasks of oina players when hitting the ball with a bat has been accepted for publication in *Bulletin of Transilvania University of Brașov*.

Vedula, G., and Sherwood, J.A. (2004). An experimental and finite element study of the relationship amongst the sweet spot, COP and vibration nodes in baseball bats. *Proceedings of the 5th Conference of Engineering of Sport*, M., Hubbard, R.D., Mehta, and J.M., Pallis, (Eds.), *International Sports Engineering Association (ISEA), Vol. 2, pp. 626–632.*

Wallace, C. (2008). Coefficient of Restitution: A Comparison of Major League and Little League Baseball. *Project J1935 California State Sci.Fair*

Welch, C., Banks, S., Cook, F. și Draovitch, P. (1995). Hitting a baseball: A biomechanical description. *J. Orthop, Sports Phys., Ther., 22, 193–201.*

Weir, G., and McGavin, P. (2008). The coefficient of restitution for the idealized impact of a spherical, nano-scale particle on a rigid plane. *Proc. Royal Society A Math., Phy.and Eng. Sci. Vol. 464 1295–307*

Williams, T., & Underwood, J. (1986). *The science of hitting*. New York: Simon & Schuster.

Wilke, D. R. (1950). The relation between force and velocity in human muscle. *J., Physiol, 110, 249-280.*

Winter, D.A. (1990). *Biomechanics and Motor Control of Human Movement* , John Wiley & Sons, Toronto,

Winter, D. A. (1991). The Biomechanics and Motor Control of Human Gait: Normal, Elderly and Pathological. *2nd Edition, Waterloo Biomechanics, Waterloo, Ont.,*

Yanai, T. (2007). A mechanical cause of body rotation about the vertical axis in baseball batting. *Poster session presented at the annual meeting of the American Society of Biomechanics, Cleveland.*

Zatsiorsky, V. (2002). *Kinetics of Human Motion*, Champaign, Illinois,

Zhang, J., Sorby, H., Clement, J., Thomas, C., Hunter, P., Nielsen, P., et al. (2014). The MAP Client: User-Friendly Musculoskeletal Modelling Workflows. *In: Bello F, Cotin S, editors. Biomedical Simulation: Springer International Publishing; p. 182-92.*

Aclands.DVD.Atlas.-.Human.Anatomy.1of6Upper.Extremity.Divx6.mp3.wogre

Aclands.DVD.Atlas.-.Human.Anatomy.2of6Lower.Extremity.Divx6.mp3.wogre

Aclands.DVD.Atlas.-.Human.Anatomy.3of6The Trunk.Divx6.mp3.wogre

A Coach's Reference Guide to Baseball Fundamentals - assets.ngin.com

assets.ngin.com/.../HALL_Coaches_Reference_Guide_to_Baseball_Fundamentals.pdf

http://biblioteca.regielive.ro/proiecte/medicina/sistemulosos-349316.html, vizitat iulie 2019

http://joculdeoina.ro

https://vicon.com/press/2015-12-02/vicon-vantage-helps-derby-university-search-for-the-perfect-golf-swing

www.incesa.ro

www_RegieLive_ro_biomecanica.zip, vizitat iulie 2019

www.scrigroup. Modelulantrenamentului-sportiv14912.php

www.vrasti.org/evaluarea%20anxietatii.pdf