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OPTIMIZATION OF BIOMECHANICS IN THE GAME OF FOOTBALL AT THE AGE OF 10 – 12 YEARS THROUGH COMPUTER TECHNOLOGY

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Abstract

The topic of the research is part of the sphere of interest of the specialists in the field, dealing with one of the most important aspects within the training process of footballers aged 10-12 years. The importance of this study is represented by the use of specially selected software for the purpose of optimizing biomechanics in the game of football. The objectives of the research are aimed at optimizing the biomechanics of kicking the ball at the age of 10-12 years by means of three basic procedures. Within the research were used the method of studying the specialized literature, the method of pedagogical experiment, the method of graphic representation, the statistical method – mathematics. Within the pedagogical experiment method, a series of tests were applied specially designed for the investigation of the components of proprioception, which have a basic role in optimizing the biomechanics of hitting the ball in the game of football. Following the analysis and interpretation of the results, it was found the validity of the research hypothesis through the progress made by the research subjects at the final testing compared to the initial one. The conclusions of the research recommend the validated experimental model within the method of training of children aged 10-12 years for the optimization of the biomechanics of kicking the ball.

Keywords: ***football, biomechanics, optimization, software, proprioception***

Introduction

Biomechanics represents both the movement of the body segments (actions), from the moment of starting the execution of a technical process until its completion, and the rules that must be observed in order to achieve an efficient execution.

The methodology of technical training follows the following aspects:

- The correct appropriation of the motor act that is being learned;
- Execution of technical processes learned in the form of technical-tactical structures;
- Execution of technical processes in various complex situations;
- Improvement of procedures under adverse conditions.

In the following paragraphs we will make a general description of the biomechanics of the most important technical elements.[1]

Taking over the ball is an indispensable technical element of any player, which allows the athlete to control the ball for future actions (pass, shot at goal, cross, etc.). The correct execution is the condition that can transform this technical element into an advantage.

A. Taking over the ball with the inside of the foot

a. Description–The movement begins by approaching the position of the ball moving towards the player. It is placed in the direction of the ball, the support leg being slightly flexed from the knees; the shoulder on the same side as the support leg is positioned forward, and the arms slightly raised to the side. The leg opposite to the support one is twisted from the hip, with the longitudinal axis perpendicular to the direction of the ball; contact with the ball will be made with the wide, either by damping (retreating to the back of the foot) or by exercising a movement from the back to the forward (execution that allows the player to continue the action at speed).

b. Tactical use - The process is used when changing the direction of play or in order to prepare for a goal.

c. Common mistakes:

- The support leg is not in the direction in which the ball is to be transmitted;

[1] Wesson J. (2002). The Science of Soccer, IOP Publishing Ltd;

- Contact with the ball is made through rigid movements, and the player can no longer control it.

B. Ball management

a. Description–Technical element by which the player in possession moves inside the playing surface, repeatedly hitting and pushing the ball with the inside, outside of the foot or with the lace, the differences between the three processes being insignificant.

b. Use - For the purpose of overcoming the opponent.

c. Common mistakes:

- The ankle of the foot, with which the ball is controlled, is too tense;
- The ball is hit too hard or too slow;
- Few touches are made.

C. Hitting the ball wide

a. Description - Movement begins by approaching the position of the ball, which can be moving or static; the player is placed towards the direction where the ball is to be transmitted, the support leg is slightly flexed from the knees, the shoulder, on the same side as the support leg, is directed to the direction where the ball is to be transmitted. The leg opposite the support one is twisted from the hip, with the longitudinal axis perpendicular to the direction of the ball, contact with the ball being made with the wide, using a "pendulum" movement (retreating back of the foot).

b. Use - For the purpose of transmitting the ball.

c. Common mistakes:

- The support leg is not in the direction on which the ball is to be transmitted;
- Contact with the ball is made by rigid movements;
- The ball is not hit in the center to ensure an accurate pass.[2]

D. Kicking the ball with your foot with the lace full

a. Description - The player's momentum depends on the distance at which the ball is intended to be transmitted and the force of the kick. The supporting leg, by its positioning, provides the direction and trajectory of the ball. The body has a forward movement, slightly bent, the shoulders are brought forward. The shoulders and arms have a swivel movement in the direction of the kicking leg, and the arm opposite to the kicking leg will reach the front of the body for balancing. The kicking leg is bent from

the hip joint and flexed from the knee. The player performs a pendulum movement forward; at the moment of hitting the ball the knee begins to flex. Pendulum provides distance and trajectory of execution. The arms contribute to the performance of the hitting movement, while also having a role in maintaining balance.

b. Use:

- In changing the direction of the game;
- In launching a counterattack;
- In the execution of shots for goal.

c. Common mistakes:

- The supporting leg is not correctly positioned;
- The ankle is not strained;
- The trunk is tilted back, the ball having a high trajectory.[2]

We look at the pendulum movement as a complex one, which can be executed from various positions. Normally, it consists of two phases: one of preparation, in which the foot is taken to the rear, and the second, execution, in which the foot is energetically projected forward in order to hit the ball. Throughout these phases, the body rests on one leg, the trunk and upper limbs having the role of maintaining balance.

In the preparation phase, the lower limb performs an extension movement using the hip joint, a knee flexion and a plantar flexion of the foot. We can say that this movement has, from a biomechanical point of view, the role of putting into tension the muscular chain that will perform the shot. Movement exerts traction on these muscles, which causes elongation, which leads to the accumulation of a potential energy needed in the next phase. [3]

In the execution phase, the lower limb will execute a vigorous movement forward, which will lead to contact of the foot with the ball. Movement is composed of thigh flexion on the pelvis, knee extension and slight dorsal flexion in the ankle joint. If the ball is hit with the outer or inner part of the boot, slight pronation or supination movements of the foot will also be performed.[4]

[2] https://www.slideshare.net/mickysima/fotbal-curs-de-baza-13518583
[3] https://www.academia.edu/33190038/BIOMECANICA_LOVIRII_MINGII_CU_LATUL_PICIORULUI_DE_PE_LOC;
[4] Manno R. (1987). La formazione della tecnica, Didattica del movimento

In the game of football, the ball is hit in a variety of ways, depending on the circumstances. For a precise pass, for example, the ball is more pushed wide, than hit. For a powerful shot, the ball is hit with the "lace". In general, the kick is concentrated in the middle of the ball, but in some situations, a certain rotation is induced to the ball. The "effect" can be imprinted to the ball by a hit above, belowor to the side of the centre of gravity.

Depending on the timing of the game and the shot that is required, for example, a penalty kick, or a shot for goal, we find two basic elements in the process of hitting the ball. The first is the pendulum of the foot to the back, to impregnate the foot speed, and the second is the moment when the foot makes contact, effectively, with the ball. In general, the movement of the foot occurs in a tenth of a second, and contact with the ball lasts a hundredth of a second.

For quick kicks, the foot needs the maximum speed, which it will transfer, in the climax, to the ball. To get to this point, the knee is flexed, while the leg is taken back. This allows the foot to accelerate on a long trajectory, giving rise to a high final speed. As the foot approaches the impact zone, it will stretch and the impact will occur with the leg blocked. If all movement takes place without loss of energy, the speed impregnated by the ball will follow the degg laws of conservation (the law of conservation of energy and the law of conservation of the angular moment). These two laws determine the speed of the foot during impact, being correlated with the determination of the speed of the ball.[5]

The supporting leg is generally slightly flexed in all joints, the position being ensured by the dynamic, failure contraction of the triple extension. Frequently, at the time of the shot, an extension occurs to the support leg, also provided by the chain of the triple extension, through the contraction of defeat. [6]

[5] Strudwick T. (2016). Soccer science, Library of Congress Cataloging-in-Publication Data;
[6] Nenciu G., Coconetu M. (2012) – Implicații ale Biomecanicii în Activitatea Sportivă, Academia Națională de Educație Fizică și Sport, Editura Fundației de Mâine, București, România;

Methods used in research

The working hypothesis assumes that the use of computer technologies will lead to the biomechanical correcting of the kicking of the ball.

Thewaxing took place over a period of eight weeks, on a number of 160 subjects, at a sports base in Brasov County, where both the proposed experimental program and the control tests used in the research were applied .

In both the initial and final testing, the animation software DeepMotion V3.5.23 was used, through which we graphically highlighted the execution differences between the initial and final tests of the subjects as well as the actual visualization of their correction degree.

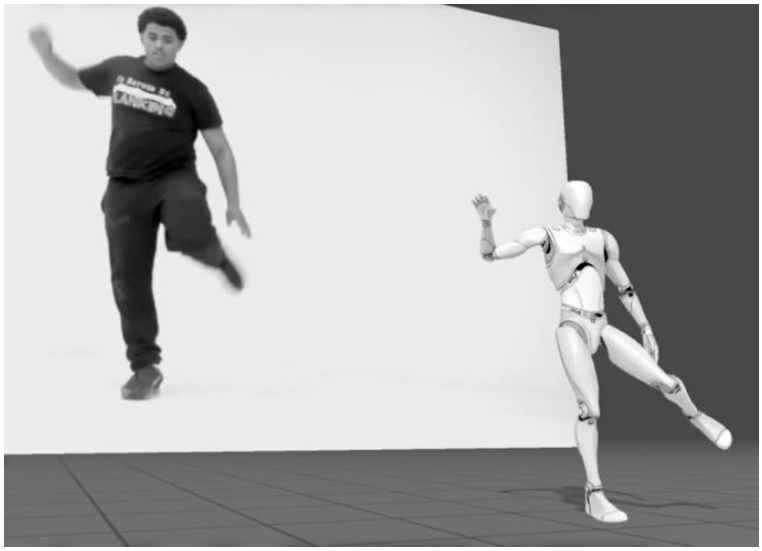

Figure no. 1 Soft animation DEEPMOTION ANIMATE 3D V3.5.27[6]

The first test used in the research was the "vulnerable areas of the goalkeeper", which consists of positioning the player at a distance of 14m from the goal from where he will shoot 20 times consecutively in the areas marked by the training net. The first execution will be in the lower left part (the root of the bar), the second execution will be in the upper left part (upper corner), the third execution will be in the upper center part (under the crossbar), the fourth execution will be in the upper right (upper corner), and the fifth

[7] https://blog.deepmotion.com/2020/08/26/animate-3d-version-1-6-0-release/

execution will be in the lower right (at the root of the bar). Four shots will be executed for each target. Only the executions in which the ball goes to the goal will be scored.

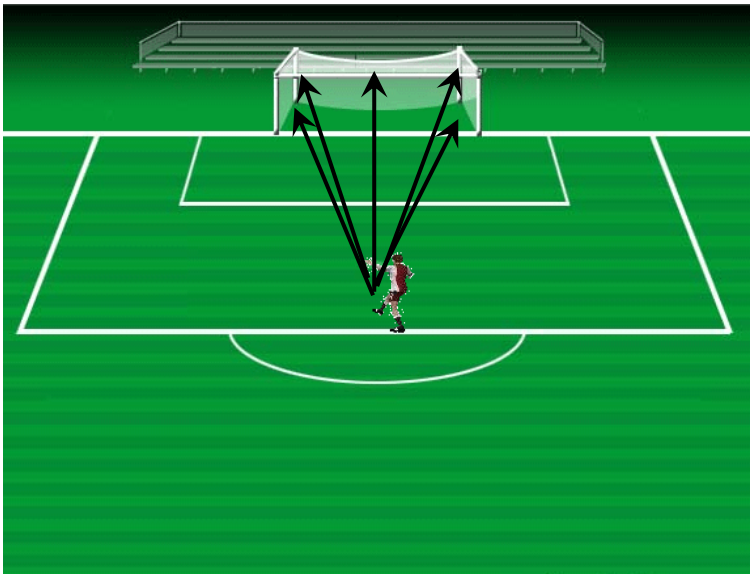

Figure no. 2 The test "vulnerable areas of the goalkeeper"

The second test used was the "shot at a fixed point" consists of positioning the player at a distance of 11m from the goal, from where he will shoot a number of 30 shots, consecutively, in the areas marked by the training net, the series starting from the lower left side. After every 10 strokes executed, the player will take a break of 20 seconds, after which the exercise will continue. Both the executions in which the ball goes through the target and the transmission of the ball through the holes of the training net will be punctuated, following the order: bottom left, top left, center, top right, bottom right.

Research results

We present below the average values recorded by the subjects involved in the research for the two samples and their graphic interpretation.

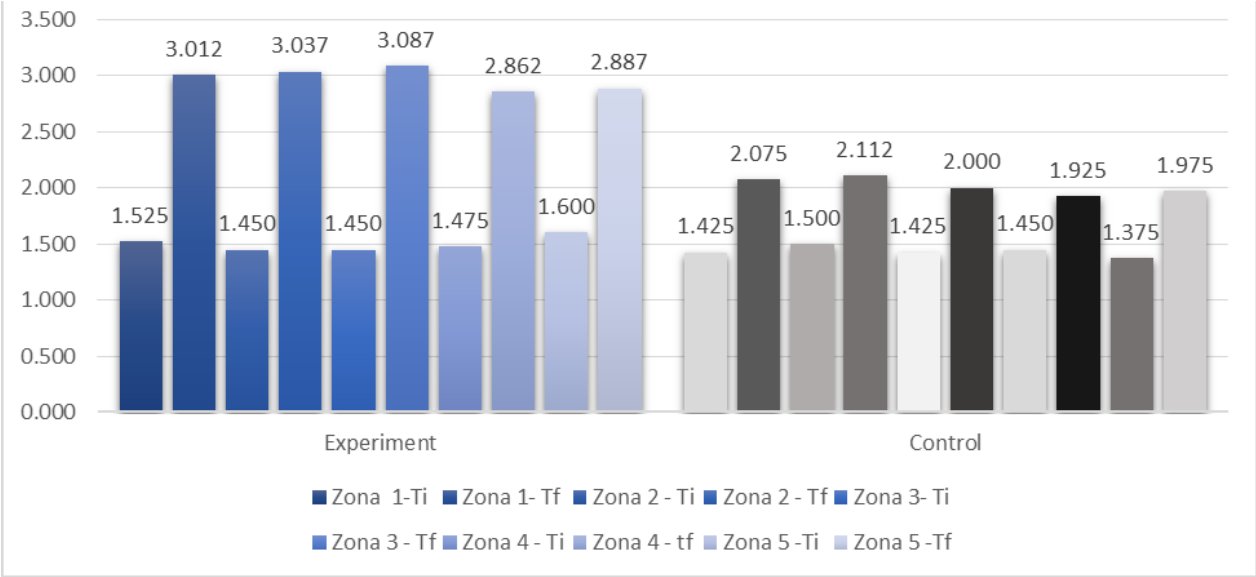

Chart no. 1 Representation of differences in the IT/FT averages for the sample – Vulnerable areas of the goalkeeper

In the research, in the "vulnerable areas of the goalkeeper" test, the experiment group had an arithmetic average of 1.52 executions at the initial testing and 3.01 executions at the final testing for executions in zone 1, and the control group had an arithmetic average of 1.42 executions to initial testing and 2.07 executions to final testing. For shots in zone 2, the arithmetic mean of the experiment group in initial testing was 1.45 executions, and for final testing it was 3.03 executions. The control group had an arithmetic average for kicks in the same area of the goal of 1.50 on initial testing and 2.11 on final testing. For shots in zone 3, the arithmetic mean of the experiment group in the initial testing was 1.45, and in the final test 3.08, and that of the control group in the initial testing was 1.42 executions, while in the final test the arithmetic mean was 2.00 executions. For zone 4, the arithmetic mean of the experiment group in the initial testing was 1.47 executions, and in the final test 2.86 executions. The control group averaged 1.45 in the initial test compared to 1.92 in the final test. For the last vulnerable area of the goalkeeper, namely zone 5, the experiment group recorded an arithmetic average of 1.60 executions, and in the final test the recorded average was 2.88 executions. Within the same area, the control group averaged 1.37 executions in initial testing and 1.97 executions in final testing.

Fig. No. 3 Biomechanics of kicking the ball for the sample "vulnerable areas of the goalkeeper"

Analyzing comparatively the 2 animations we find the following aspects:

- At IT the subject manifests an unstable degree of balance during the process of kicking the ball, while at FT the subject corrects his balance;
- Within IT, the subject manifests a weaker coordination when kicking the ball, resulting from the suddenness of the movement performed for this purpose, while in the FT the acquired superior coordination is manifested by the degree of relaxation and by the naturalness of kicking the ball.

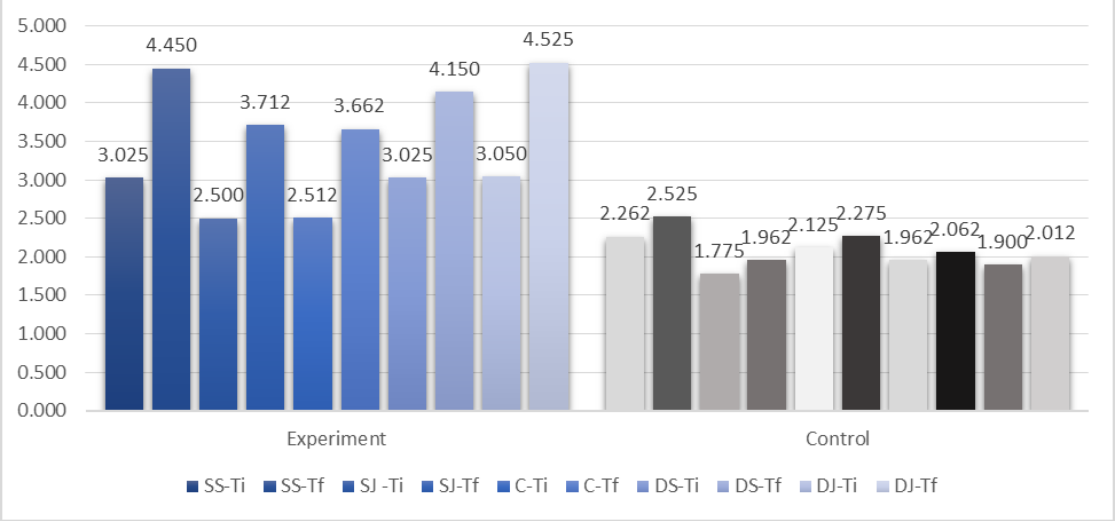

Chart no. 2 Representation of the arithmetic mean IT/FT for the sample–Shot at fixed point

For the current sample, the experiment group registrated an arithmetic mean of 3.02 executions in the initial testing and 4.45 executions in the final test for executions in the upper left, and the control group had an arithmetic average of 2.26 executions in the initial test, and 2.52 executions at the final test. For kicks in the bottom left, the arithmetic mean of the experiment group in the initial testing was 2.50 executions, and for the final test it was 3.71 executions. The control group had an arithmetic average for kicks in the same area of the goal of 1.77 on initial testing and 1.96 on final testing. For center shots, the arithmetic mean of the experiment group in the initial testing was 2.51, and in the final test 3.66, and that of the control group in the initial testing was 2.12 executions, while in the final test the arithmetic mean was 2.27 executions. For shots in the upper right, the arithmetic mean of the experiment group in the initial testing was 3.02 executions, and in the final test of 4.15 executions. The control group averaged 1.96 in the initial test compared to 2.06 in the final test. For the last area, namely the bottom right, the experiment group recorded an arithmetic average of 3.05 executions in initial testing, and in the final test the recorded average was 4.52 executions. Within the same area, the control group recorded an average of 1.90 executions in initial testing and 2.01 executions in final testing.

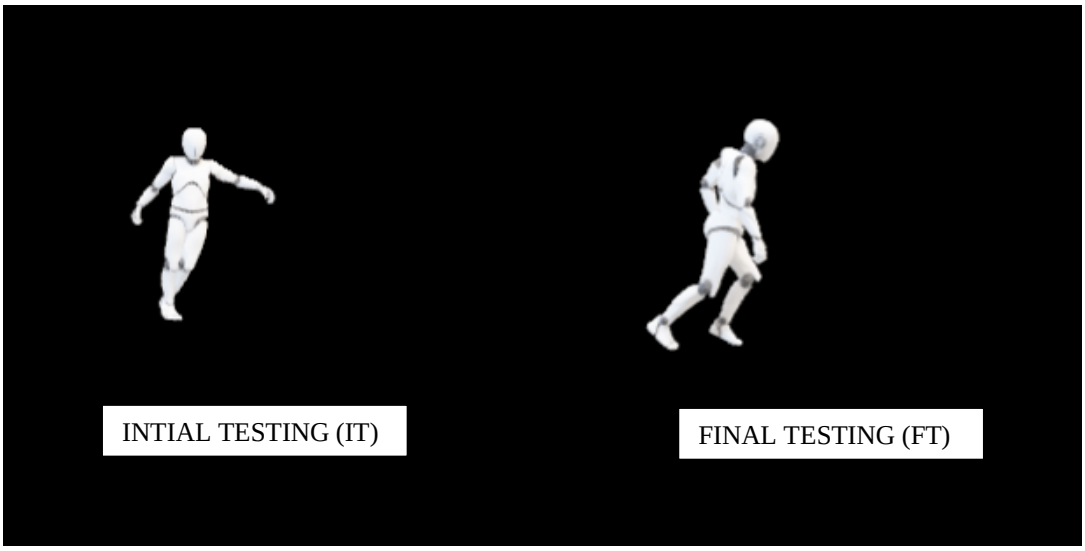

Fig. No. 4 Biomechanics of kicking ball for the sample "shot at fixed point"

Analyzing comparatively the 2 animations we find the following aspects:

- In IT the subject manifests an unstable degree of balance during the kicking of the ball, while at FT the subject corrects his balance;
- Within IT, the subject exhibited a weaker coordination of the kicking of the ball resulting from the suddenness of the measures carried out for this purpose, while at the FT the superior coordination gained was manifested by the degree of relaxation and naturalness of hitting the ball with the foot;
- In the IT, the posture of the subject presents an extension of the spine materialized by the displacement towards the turn of the body's center of gravity, which affects the degree of balance, while within the FT the subject corrects these parameters;
- The pendulum movement of the foot at the FT is similar to the movement of a basketball player's hand when he throws to the basket, this chasing the ball for increased accuracy.

Conclusions

The main objective of the research, represented by the optimization of biomechanics in the game of football at the age of 10–12 years, with the help of information technology, was achieved, an aspect that results from the significant differences recorded by the subjects of the experiment group in the two samples analyzed within the research.

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