

ORIGINAL ARTICLE



The Effect of an Electronic Device Designed to Measure the Knee Bending Angle in Developing the Skill of Catch and Clearance the High Ball for Football Goalkeepers

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ABSTRACT

Background. The use of modern aids and technology has contributed greatly to football development, the goalkeeper is the most important position in the team, and the use of devices gave objective readings about the goalkeeper's ability in terms of skill and physical aspects. **Objectives.** The research aimed to prepare exercises using an electronic device to measure the knee bending angle because of its great importance in developing the skill of catching and dimensions of the high ball for football goalkeepers. **Methods.** The researchers used the experimental method, and the sample consisted of 4 male goalkeepers under 15 years of age, one of the research procedures was to determine the biomechanical variables affecting the development of the skill under study, where the training program was prepared according to an electronic device designed by the researchers. **Results.** There are significant differences ($p < 0.05$) between the pretest and post-test and in favor of the results of the post-test of the researched variable among the individuals of the research sample. **Conclusion.** The researchers concluded that the use of assistive means and electronic devices, including the designed device, contributed significantly to developing the skill of catching and clearance of the high ball through the exercises prepared on the device.

KEYWORDS: *Football, Goalkeeper, Knee Bending Angle, Catching High-Altitude Balls.*

INTRODUCTION

The great development witnessed by the world in all fields, including the sports field, has led to the development of Sports levels and the achievement of great achievements for various sports events, and these achievements did not come by chance or out of a vacuum but were achieved thanks to the ability of researchers and specialists to employ various sciences and through proper scientific planning to serve the achievement in these events (1).

Football is one of the prominent sporting events that has received increasing attention from various

countries and at all levels. Such interest has made researchers always strive to develop the game by raising the levels of players from a physical, tactical, and psychological perspective, in addition to developing their skill aspect (2). Football has become an extremely competitive sport, with teams striving to gain an edge over their opponents. This has led to the development of specialized strategies and techniques to improve player performance and win more games (3), Technological advances such as data analytics and AI have further improved the game (4).

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The goalkeeper has special importance and a great responsibility in football matches (5). A poor performance by the goalkeeper may lead to losing the match, while a good performance can secure the match. It is one of the most special positions in football and its primary function is purely defensive, specializing in defending the team's goal (6). Against the opposing team's attackers and preventing them from scoring goals, this task requires special specifications, as the goalkeeper must have physical and skill capabilities in addition to choosing the correct technique and position through the appropriate angles, especially the knee angle, as it is one of the most important angles influencing readiness and preparation for flight (6).

The skill of catching and clearance the high ball is one of the skills used by the goalkeeper to catch the high lateral ball that comes from the fixed ball, or from the moving ball by the opposing team player who lifts it high to his attacking colleague, then the goalkeeper comes out to catch it and cut it off from the attackers, and the receipt of the high ball from the side by the goalkeeper is in the form of a dueling movement in the case of defensive retreats nearby (7). The goalkeeper has to regulate the timing of jumping and catch the ball with his hands, and he has to bend his arms to put the ball between his hands, arms, and chest and put the weight of his body when he goes down from jumping on the back foot (8), and Mufti Ibrahim says, "on the goalkeeper, as soon as the ball meets the fingers, the hands work to absorb the force of the ball, and this is done from the joints of the wrists, elbows, and shoulders, as the arms come back a little" (9), and here we emphasize the goalkeeper's readiness posture and take the appropriate position to the degree of bending the knee angle (10).

Modern technology and auxiliary tools are considered one of the main factors contributing to the development and improvement of the basic skills of goalkeepers (11). Training in management assistance is an important applied aspect aimed at reaching the player to the correct performance that provides the correct movement mechanism, so it requires the goalkeeper to take the correct skill technique at the right time adapted to different playing situations, and this is not achieved by simply relying on exercises (12), but the training process has adopted the auxiliary tools that those responsible hope to accelerate the process of development of skill ability, as approaching the optimal performance form and method is a fundamental duty of the training process (13).

Hence, the importance of research into designing a device to measure the knee bending angle and using it in training for the purpose of developing the skill of catching and dimensions of the high ball by using the appropriate bending of the knee angle.

MATERIALS AND METHODS

The researchers used the experimental method using the method of the two experimental and control groups in an intentional way, where 2 goalkeepers were excluded due to injury. The sample was selected from Baghdad governorate clubs (Al-Zawraa Sports Club under 15 years). The sample consisted of 4 male goalkeepers. the researchers took anthropometric and biological measurements and recorded them in the measurement form, and then the researchers identified the most important biomechanical variables affecting the skill of holding and distancing high balls, as shown in Table 1.

Table 1. Shows the homogeneity of the sample according to growth indicators

The variable	Unit of measurement	mean	median	Standard deviation	Skewness
height	Cm	180.25	180.50	3.5	0.321
Weight	Kg	67.5	65	2.38	0.01
Age	Year	12.87	12.75	0.85	0.75
Training age	Year	2.95	2.9	0.42	0.64

Knee angle curvature measuring device.
The work of the device: This device gives instantaneous measurements of the degree of curvature of the knee angle.

Device Description: The machine is manufactured by Arduino Uno R3. The device is attached by a special rubber rest. The device is designed to give comfort when performing.

The goalkeeper wears it when performing the test. The device has two entry ports, the first for the purpose of connecting electricity to the device. It operates with a voltage 5V, and the second (USB) port for the purpose of giving orders and programming the device. The device in turn has two outlets for the purpose of connecting voltage (L, N) in addition to the

reference to sensors as shown in [Table 2](#) and [Figures 1](#), and [2](#).

Method of operation: the goalkeeper wears the device at the knee joint where there is a sensor (flex Sensor). The device is connected to the power source (lithium battery) and the device is turned on and connected to Bluetooth via the mobile, and as soon as the first movement starts, the sensors send a digital data signal to the mobile via Bluetooth, where they review the values of the degree of curvature of the knee angle over time.

Tools used: questionnaire form, SPSS program, Footballs number 4, Surface Laptop ([3](#)).

The main experience: The pretests were held on 25-05-2023 at the stadium of the Iraqi football club Al-Zawra'a.

The high ball catch and clearance test was applied as follows:

High altitude ball catch test ([14](#)):

Purpose of the test: Measure the goalkeeper's skillful ability to catch high balls over the head.














Necessary tools: Half of a regular football field, Goalkeeper in the penalty area, football number 10, Legal goal, Soccer Training Cones, Tape measure, Registration form, Whistle.

Performance method: The goalkeeper stands in the place specified for him in the goal and according to the position of the ball from the goal, and upon hearing the instruction by the coach, the goalkeeper must go out of the goal to the divided areas to catch the ball high in front of the penalty area as shown in [Figure 3](#).



Figure 1. Knee angle curvature measuring device.

Table 2. Materials used in the manufacture of the device

No	Device Parts	No	Purpose	Figure
1	Connecting wires (Breadboard Jumper Wires)	1	deliver power (L, N) from the Arduino microcontroller board to the board	
2	Connecting wires (Row Dupont Cable M-F)	1	used to connect the sensor in the Arduino microcontroller board	
3	Connecting wires (Row Dupont Cable F-F)	1	used to connect the sensor in the Arduino microcontroller board	
4	battery connector	1	deliver power from the battery to the Arduino microcontroller board	
5	lithium Battery	2	deliver power to the Arduino microcontroller board	
6	flex Sensor number	1	Sensor to the measurement of elasticity extracted through the value of the angle by software code	
7	0.5 mm Copper wrapping wire reel 30 AWG 3-pin	1	used to connect the signal and electricity between the ports	
8	Microcontroller board (Arduino Uno R3)	1	a smartboard that is programmed by code to implement what is required of it by several sensors that input, read, and extract the signal via Bluetooth or monitors, etc	
9	lithium holder	1	the rectangular base for carrying the battery	
10	HC-06: Bluetooth	1	Bluetooth connector for data extraction to the mobile	
11	1000um impedance	1	used with a flexibility sensor to adjust the reading value	
12	Arduino base	1	used to carry and install the Arduino.	
13	knee belt	1	The device is attached by a knee belt to easily attach it to the knee joint	

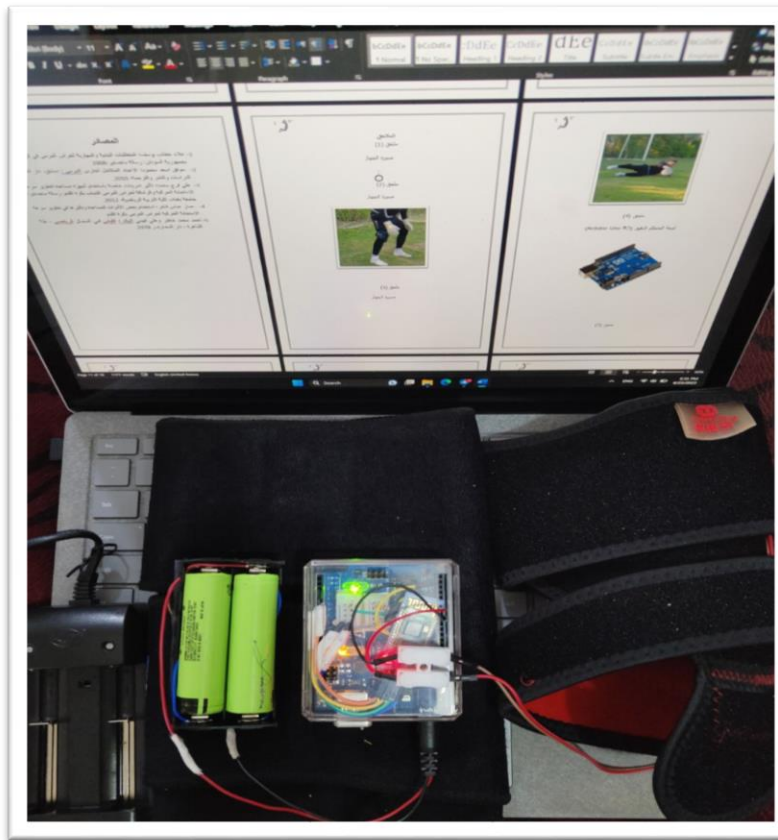


Figure 2. The device in its final form.

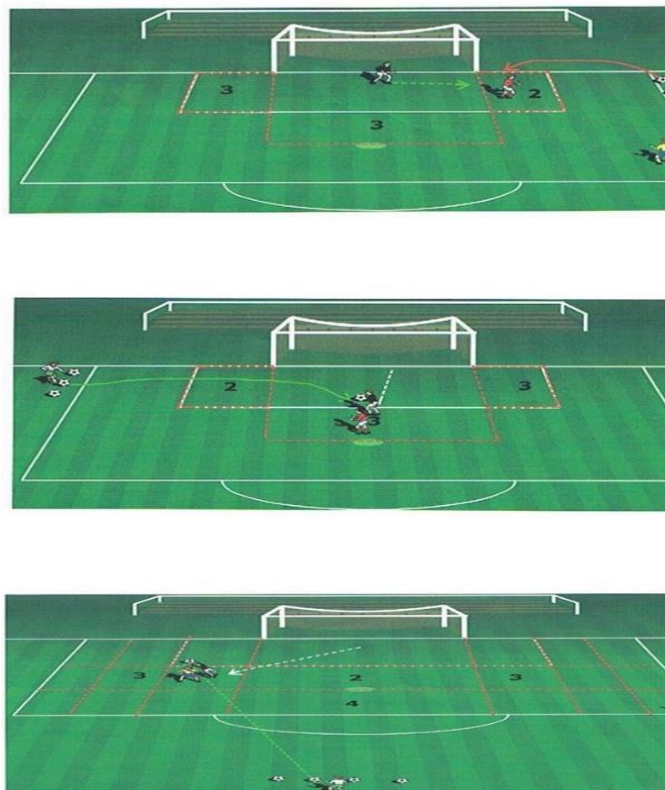


Figure 3. High altitude ball catch test.

Recording method:

- 3 points are awarded when the ball is caught completely directly from above and above the opposing player.
- 2 points are given when catching the ball in two batches.
- 1 A point is awarded when the ball is removed from above the opposing player.
- 0 points are awarded as a zero in case the tester does not reach the ball, or the ball enters the goal by the opposing player.

The sum of the scores of the ten attempts is calculated: (Total try scores 10/10=post-test grade)

Test conditions:

- The tester (goalkeeper) is given ten balls, 4 balls from the front, and three 3 balls for each side from outside the penalty area.
- The goalkeeper's exit is within the designated test area according to the division of the penalty area.
- The other goalkeeper enters as the opposing player in these areas to increase the competition between the testers and the speed of the goalkeeper to catch the ball from the highest point, according to international football law (IFAB).

If the ball does not reach the specified places from the coach, the attempt is repeated.

The researchers prepared special exercises according to the designed device and the skill of catching and clearance the high ball for goalkeepers in football. The exercises were applied in the main section of the training unit and under the direct supervision of the researchers on Saturday, 30/05/2023. The application of the exercises ended on Thursday, 25/07/2023, on the research sample, and in proportion to the level of the sample and their skill and motor abilities, The researchers sought to prepare these training of 24 training units over two months 3 units per week.

A sample of a daily training unit.

1) The Objective of the training: to develop the skill of catching or clearance a medium-height ball for football goalkeepers.

Goalkeepers: Number 4.

Exercise tools: knee angle measuring device, football number 15, football field penalty area, training mannequins Opposite the goal in the center.

Number of repetitions: 10–15.

Number of Sets: 2.

Positive rest between groups: 5 minutes.

The method of performing training: the device is placed on the inside of the knee joint and the goalkeeper stands ready in the center of the goal when the ball is shot by the coach on the training mannequins, the goalkeeper receives a rebound ball from the training mannequins, the goalkeeper then prevents the ball from entering the goal, either catching it or clearance it away the training is performed (right and left) according to the direction of the ball.

2) The Objective of the training: is to develop the skill of catching or clearance a medium-height ball for right-sided football goalkeepers.

Goalkeepers: Number 4.

Exercise tools: knee angle measuring device, football number 15, football field penalty area, and training mannequins Opposite the goal on the left.

Number of repetitions: 10–15.

Number of Sets: 2.

Positive rest between groups: 5 minutes.

The method of performing training: the device is placed on the inside of the knee joint and the goalkeeper stands ready on the left side of the goal when the ball is shot by the coach on the training mannequins, the goalkeeper receives a rebound ball from the training mannequins on the right side, the goalkeeper then prevents the ball from entering the goal, either catching it or clearance.

3) The Objective of the training: is to develop the skill of catching or clearance a medium-height ball for left-sided football goalkeepers.

Goalkeepers: Number 4.

Exercise tools: knee angle measuring device, football number 15, football field penalty area, and training mannequins Opposite the goal on the right.

Number of repetitions: 10–15.

Number of Sets: 2.

Positive rest between groups: 5 minutes.

The method of performing training: the device is placed on the inside of the knee joint and the goalkeeper stands ready to the right of the goal when the ball is shot by the coach on the training mannequins, the goalkeeper receives a rebound ball from the training mannequins on the left side, the goalkeeper then prevents the ball from entering the goal, either catching it or clearance.

The Post-test was conducted on 30-07-2023 at the stadium of the Iraqi football club Al-Zawra'a and the high ball catching and clearance test was applied to find out the extent of the effect of the exercises prepared according to the device designed on the sample under study.

RESULTS

Once the researcher has completed the tests on the research sample, the findings are presented in Tables, displaying their statistical values. This step is crucial as it serves as an

illustrative tool for the research. The results are then thoroughly discussed. To enhance clarity, the findings will be sequentially presented and discussed for each variable that was studied as shown in [Table 3](#).

Table 3. Shows the statistical values of the individuals in the research sample

The variable	Unit of measurement	pretests		Post-test		Skewness	t	p
		mean	Standard deviation	mean	Standard deviation			
Catching high-altitude balls	Point	16.10	3.57	18.10	4.30	2.00	3.56	0.01

At a degree of freedom 3 and $p < 0.05$.

Presentation and analysis of the results of pre- and post-tests of the catching skill and the clearance of the high-altitude ball among the members of the research sample.

shown in [Table 3](#) that the value of the arithmetic mean and standard deviations of the pretests and post-test of the results of the altitude high ball catching test is as follows:

The value of the arithmetic mean of the results of the pretests among the members of the research sample was 16.5, while the amount of its standard deviation was 3.57, and the value of the mean of the post-test was 18.10 with a standard deviation of 4.30, while the amount of differences in the mean between the first and the post-test was 2.00. By treating these results statistically, it turned out that the value of t was 3.56, and the error rate was 0.01. It is below the level of significance 0.05 by a degree of freedom 3. This indicates that there are significant differences between the pretest and post-test and in favor of the results of the post-test

of the researched variable among the individuals of the research sample, the results indicated that there is a percentage of the evolution of the results of this variable.

[Table 4](#) shows that the mean and standard deviation values of the pre- and post-tests for knee angle test results are as follows:

The mean value of the pre-test results for the knee angle of the first goalkeeper was 85° , with a standard deviation of 11.790. The mean value of the post-test results was 105° , with a standard deviation of 13.077. The mean value of the pre-test results for the knee angle of the second goalkeeper was 88° , with a standard deviation of 7.000. The mean value of the post-test results was 100° , with a standard deviation of 4.583. The mean value of the pre-test results for the knee angle of the third goalkeeper was 92° , with a standard deviation of 5.292. The mean value of the post-test results was 110° , with a standard deviation of 8.544.

Table 4. shows the data of knee angle for the pre- and post-tests of the sample

No	Pretests		Post-Test	
	Mean	Standard Deviation	Mean	Standard Deviation
First Goalkeeper	85	11.790	105	13.077
Second Goalkeeper	88	7.000	100	4.583
Third Goalkeeper	92	5.292	110	8.544

DISCUSSION

The results were presented in [Table 3](#) between the pre-test and post-test for the catching skill and the clearance of the high-altitude ball in favor of the post-test. The researcher attributes this to the application of exercises using the designed device has contributed significantly to the development of skills among the members of the research sample

in terms of taking the appropriate position to prepare and make the right decision to tackle the ball, These exercises develop the motor program of the skill in a way that suits the anthropometric measurements and the physical and skill abilities of the goalkeeper, which helps him achieve more understanding of the nature of exercise performance, which makes him succeed in performing skills in various playing situations,

The auxiliary tools also motivate the goalkeeper to perform exercises with desire and enthusiasm, as well as when placed with training modules that generalize motor programs, and this is reflected on the skill performance in the match. Where the movement of goalkeepers with the corresponding leg had a positive effect on the knee angle in terms of the transfer of body parts with greater angular momentum. This was confirmed by a study by Ibrahim et al., (2019), in which the full body movements of elite goalkeepers were measured as they jumped to save high and low balls on either side of the goal. The results showed that goalkeepers adopted a ready position with a stance width of $33\pm1\%$ of leg length, a knee flexion angle of $62\pm18^\circ$, and a hip flexion angle of $63\pm18^\circ$ (15).

The results showed that the importance of the knee angle is highlighted to a great extent during the ready stance as it is considered the first path to start the skill and prepare for flying, and this is what was confirmed by the study of Ibrahim et al., (2019), where identifying the optimal preparatory position for goalkeepers is of great importance to improve the performance of goalkeepers in defending balls. The study aims to analyze the effect of the ready stance and knee flexion angles on the movement time, the trajectory of the center of mass, and the speed in the saves of goalkeepers (16).

The researchers add that the method adopted in building the exercises prepared according to the use of the designed device contributed to achieving these moral results, as well as focusing on giving the appropriate and accurately programmed repetitions commensurate with the capabilities of the research sample members, and continuous guidance by the support team in motivating them to implement these exercises while working to correct errors by repeating the research sample also contributed to the positive effects on the development of their level, through the formation of the training load and changing its ratio and types.

CONCLUSION

In conclusion, the experimental group of goalkeepers used the designed device more effectively and with immediate corrections. This led to a significant improvement in their ball-catching and Clearance skills. The researchers also found that it is important to build exercises according to specific knee joint angles. This is

because the knee joint is closely associated with the process of sequentially transferring body parts to reach the flight stage with the best performance to intercept balls. In the pre-tests, some of the goalkeepers in the study relied on the lowest degree of knee joint angle for flight, especially for high lateral balls. This is a misconception, as the readings of the designed device showed that the optimal knee joint angle varies from goalkeeper to goalkeeper. This is because it is associated with anthropometric measurements and other physical variables.

APPLICABLE REMARKS

- Emphasizing the use of exercises using auxiliary means because of its extremely important impact on the development of the skill of catching and clearance the high-altitude ball among football goalkeepers under 15 years.
- The researcher recommends goalkeeping coaches use regular scientifically based training curricula when preparing special exercises in terms of the sequence of exercises used, the amount of load given, the duration of breaks during the training unit, and leaving random work.

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AUTHORS' CONTRIBUTIONS

Study concept and design: Abbas Hussein Khalifa. Acquisition of data: Mustafa Ahmed Obaid. Analysis and interpretation of data: Abbas Hussein Khalifa. Drafting the manuscript: Mustafa Ahmed Obaid. Critical revision of the manuscript for important intellectual content: Mohammed Saad Rabeea. Statistical analysis: Abbas Hussein Khalifa. Administrative, technical, and material support: Mohammed Saad Rabeea. Study supervision: Mustafa Ahmed Obaid.

CONFLICT OF INTEREST

The authors stated that there is no conflict of interest present.

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