A special training program using the Peak Point device and weights and its effect on improving vertical jumping and long-range shooting accuracy for young handball players.

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Abstract

Objective: To develop a specialized training program using the Peak Point device and weights for talented national handball players aged 14-16, to identify the effect of the training program on improving the height of the body mass index (BMI) during the flexion, extension, and rest phases while performing long-range shots, and to identify the effect of the training program on improving the accuracy of long-range shooting among talented national handball players aged 14-16.

Research methodology: The researchers adopted an experimental approach with a pre-test/post-test design for equivalent groups. The research population consisted of handball players from the National Talent Center. The sample comprised 18 players, randomly divided into three groups of six players each: a control group, an experimental group (the first using weights), and an experimental group (the second using weights with a Point Peak device).

Results: The results showed the superiority of the second experimental group in all biomechanical variables and shooting accuracy. This confirmed the effectiveness of combining weights with the device in improving performance compared to training with weights alone or conventional training.

Conclusions: The standard training program contributed to maintaining performance levels and achieving limited improvement in biomechanical variables and shooting accuracy. However, this improvement did not reach statistical significance, and exercises using weights resulted in a significant improvement in the height of the body mass index (BMI) at maximum flexion, maximum extension, and rest, as well as an improvement in the accuracy of long-range shots from the jumping position among young handball players.

Introduction

Sports training is currently witnessing remarkable development because of relying on scientific principles in planning and implementing training programs. Achieving athletic success is now linked to the extent, to which modern training methods are employed, methods that align with the nature of skill performance and the demands of athletic activity. This development has contributed to the emergence of diverse training tools and equipment aimed at improving physical and skill abilities, as well as utilizing the sciences of movement and biomechanics in performance analysis and evaluation to reach the highest possible level. The use of specific exercises is among the most important training methods relied upon by coaches, as it forms the basis for achieving training objectives. Its movements correspond to the requirements of skill performance and contribute to developing specific motor abilities, particularly strength, speed, and agility, in addition to its direct connection to the nature of performance in competition.

Handball is a team sport that requires players to possess a high level of physical and skill abilities due to the fast-paced and changing nature of the game. A player's success depends on their ability to execute basic skills with high efficiency and in the shortest possible time. Long-range shooting is among the most important offensive skills that directly contribute to success, as it requires the player's ability to jump appropriately and coordinate different body parts to generate the necessary force and accurately direct the ball towards the goal. Therefore, developing specific skills related to performance, particularly explosive power and speed-strength, has become a cornerstone of handball player preparation (Hashem et al., 2020 : Oleiwi et al., 2021)

Resistance and weight training is a crucial method for developing muscular strength. It involves adding external resistance in a way that suits the player's physical capabilities, leading to increased efficiency of the working muscles and improved power generation. Furthermore, adding weights to specific body parts increases muscle tension and engages a greater number of motor units compared to normal activity. This positively impacts the development of explosive power and speed-strength, provided that the resistance is applied scientifically, taking into account the gradual increase in load, the specific requirements of the sport, and the nature of the athletic skill. Because successful skill performance depends not only on developing physical abilities, biomechanics has become a fundamental science in the field of sports. It studies the movement of the human body during performance by applying mechanical principles to understand, analyze, and improve movement. This science helps identify the kinematic variables affecting performance and reveals strengths and weaknesses, providing coaches and researchers with a scientific basis for developing training programs and evaluating their results. Kinematic analysis is an objective method for studying the components of movement and the relationships between them. It clarifies how the body moves through different phases of performance and the efficiency with which force is used to achieve optimal performance (Radi et al., 2020: Hashem, et al., 2022: Radhi, & Obaid, 2020)

Therefore, the movement of a player's body during a long-range shot is not limited to generating force, but also relates to how the body mass index (BMI) moves through different phases of performance, particularly during flexion, extension, and rest. These kinematic variables reflect the efficiency of the movement and the extent to which the force generated during jumping and shooting is utilized. The smoother and more efficient the movement of the body mass index (BMI), the greater the player's ability to achieve a suitable height during the jump, the better the mechanics of the performance, and this is positively reflected in the accuracy and effectiveness of the shot. Therefore, analyzing body mass index (BMI) during these phases has become a crucial indicator for evaluating technical performance and interpreting the development resulting from training programs.

According to the technological advancements in sports training, modern training devices have emerged, that facilitate real-time performance monitoring and provide accurate feedback to both players and coaches. The Peak Point device is one such tool that can be used to track a player's performance during jumps and determine the highest point reached by the body. This helps improve movement timing and links physical development to the biomechanical changes accompanying performance. When this device is combined with weight training, a training program can be developed that combines the development of specific physical abilities with the improvement of movement variables related to skill performance. This is expected to contribute to improving BMI during flexion, extension, and rest phases, while simultaneously increasing the accuracy of long-range shooting in young handball players, which is what this study aims to investigate.

Through his observation of the training practices of young handball players, the researcher noted a disparity in the performance of the long-range shooting skill, particularly in utilizing vertical jump during execution. Many players do not achieve the appropriate height of their body mass index (BMI) during the flexion, extension, and rest phases, which affects the efficiency of the mechanical performance and limits the accuracy of their long-range shots. Furthermore, the training programs often focus on developing physical capabilities in isolation from the biomechanical variables involved in performance, with limited use of modern training equipment that provides accurate feedback during training. Therefore, the need arose to develop a specialized training program using a peak point device and weights, and to determine its effect on improving the height of the body mass index (BMI) during the flexion, extension, and rest phases, and the resulting impact on the long-range shooting accuracy of young handball players.

Research Objectives

1. To develop a specialized training program using the Peak Point device and weights for talented national handball players aged 14-16.
2. To identify the effect of the training program on improving the height of the body mass index (BMI) during the flexion, extension, and rest phases while performing long-range shots.
3. To identify the effect of the training program on improving the accuracy of long-range shooting among talented national handball players aged 14-16.

Research Hypotheses

1. There are no statistically significant differences between the pre-tests and post-tests in the variables of height of the body mass index (BMI) during the flexion, extension, and rest phases, in favor of the post-tests.
2. There are no statistically significant differences between the pre-tests and post-tests in the accuracy of long-range shooting, in favor of the post-tests.

Methodology and Tools

The researcher chose the experimental method with three groups (control, experimental group 1, and experimental group 2) using pre- and post-tests, as it is one of the most readily available scientific methods for addressing the research problem, as shown in Table (1).

Table 1. shows the experimental design of the research

Groups	Pre-test	Main Experiment	Post-test
Control Group	- Biomechanical variables measurements - Long-distance jump shot accuracy test	Coach's training exercises	- Biomechanical variables measurements - Long-distance jump shot accuracy test
First Experimental Group	- Biomechanical variables measurements - Long-distance jump shot accuracy test	Special weighted training exercises	- Biomechanical variables measurements - Long-distance jump shot accuracy test
Second Experimental Group	- Biomechanical variables measurements - Long-distance jump shot accuracy test	Special weighted training exercises using the Peak Point device	- Biomechanical variables measurements - Long-distance jump shot accuracy test

The research population was selected purposively and consisted of players aged 14-16 years at the National Handball Talent Center in Baghdad.

The researchers randomly divided the research sample into three groups (control, experimental group 1, and experimental group 2) by lottery. The researcher will ensure equivalence among the three groups in all research variables through pre-tests and before implementing the prepared exercises. It is essential to control all variables that could affect the performance of the research sample. The researcher will conduct an equivalence test using ANOVA to ensure a single starting point.

Table 2. Shows the number of players in the team and the percentage of the population.

Population	Number	Percentage
Original Population	46	100%
Research Population	26	56%
Research Sample	18	69%
Control Group	6	33%
First Experimental Group	6	33%
Second Experimental Group	6	33%
Pilot Study Sample	3	16%

Normal Distribution

The Shapiro-Wilk test values for the three groups in the research variables are presented, and the calculated Shapiro-Wilk test value and its significance level for the control, experimental group 1, and experimental group 2 in the research variables are shown in Table (3).

Table 3. Shows the Shapiro-Wilk test value and the Sig value for the normal distribution of the research groups in the biomechanical variables and the aiming accuracy test.

No.	Variables	Control Group		First Experimental Group		Second Experimental Group	
		Shapiro–Wilk	Sig.	Shapiro–Wilk	Sig.	Shapiro–Wilk	Sig.
1	Height of the body mass index (BMI) at Maximum Flexion	.901	.383	.953	.762	.910	.439
2	Height of the body mass index (BMI) at Maximum Extension	.885	.295	.912	.452	.949	.729
3	Height of the body mass index (BMI) at the Instant of Maximum Stillness	.872	.235	.825	.098	.910	.434
4	Shooting Accuracy	.822	.091	.822	.091	.822	.091

The table above shows that the sample of research groups was normally distributed during the pre-tests for the selected research variables, as the SIG value was greater than 0.05 at 5 degrees of freedom and the significance level was 0.05 in the Shapiro-Wilk inference test, indicating that both groups started from the same starting point.

Equivalence:

The researcher ensured equivalence among the research groups in the pre-tests for all research variables before implementing the prepared exercises. It was essential to control all variables that could influence the performance of the research sample. The researcher performed the equivalence test between the groups using ANOVA to confirm that they started from the same starting point, as shown in Table 4.

Table 4. shows the equivalence of the three research groups in the pre-tests for the physical variables and the target accuracy test.

No.	Variables	Source of Variance	Sum of Squares	df	Mean Square	Calculated F-value	Sig.	Significance
1	Height of the body mass index (BMI) at Maximum Flexion	Between Groups	1.098	2	0.549	0.010	0.990	Not Significant
		Within Groups	834.84	15	55.65			
2	Height of the body mass index (BMI) at Maximum Extension	Between Groups	51.25	2	25.62	0.289	0.753	Not Significant
		Within Groups	1330.81	15	88.72			
3	Height of the body mass index (BMI) at the Instant of Maximum Stillness	Between Groups	225.20	2	112.60	0.408	0.672	Not Significant
		Within Groups	4140.40	15	276.02			
4	Shooting Accuracy	Between Groups	0.111	2	0.056	0.036	0.964	Not Significant
		Within Groups	22.833	15	1.522			

Significant at a significance level less than (0.05) and 15 degrees of freedom.

The table above shows that the sample of research groups is equivalent in the pre-test values for the selected research variables, as the SIG value is greater than (0.05) on the ANOVA scale, indicating a single starting point for the selected groups.

Equipment and Tools Used in the Research:

The following equipment and tools will be used according to the research requirements in terms of tests and the main experiment: - Peak Point Device Designed by the Researcher

First: Introduction

This chapter addresses the practical aspect of designing and implementing a device to measure the highest height reached by a player during a jump or vertical movement. The device relies on measuring the distance between a measuring unit attached to the player's body and the ground surface. The distance sensor is pointed towards the ground as vertically as possible. When the player moves or jumps, the measured distance changes according to the body's upward and downward movement. The system uses a VL53L1X distance sensor to measure the change in distance and an Arduino Micro board to process the readings and determine the highest value reached by the sensor after exceeding a distance of one meter. The HC-12 wireless communication unit was also used to transmit the results to a computer-connected receiver. Additionally, a C# program was developed to display the jump results graphically, allowing for clearer monitoring of the athlete's performance and analysis of the results.

The practical aspect of the project aims to build a simple, portable electronic system capable of measuring the athlete's highest jump, then wirelessly transmitting the results and displaying them digitally and graphically on a computer.

The reading can be represented as a variable positive signal resembling a sine wave. The reading goes through three main phases:

1. Rising phase: The measured distance increases.
2. Peak phase: The reading reaches its highest value.
3. Declining phase: The reading begins to decrease after reaching its peak.

The algorithm used in this project relies on tracking the highest reading value after exceeding the one-meter threshold. Upon detecting the highest value, a buzzer is activated, and the result is sent to the receiving unit.

Second: System Overview

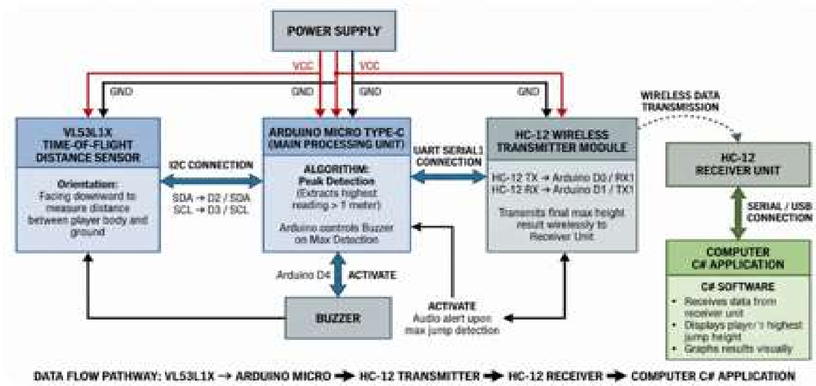
1. Player Unit
2. Wireless Communication Unit
3. Computer Display and Analysis Unit

The player unit reads and processes the distance, then sends only the final result to the receiver unit. The computer program then receives the data and graphs it.

Third: Materials and Components Used in the System

A range of electronic and mechanical components was used to build the system. The following table shows the main components used and the function of each component within the system.

Figure 1. Block diagram of the device



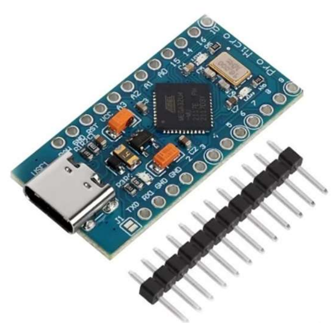
Fourth: Description of Practical Components

1. Arduino Micro Board

The Arduino Micro board was used as the central processing unit (CPU) of the device. This board is characterized by its small size, making it suitable for wearable applications or devices attached to the human body. The board reads distance sensor data via the I2C protocol and then processes the readings to determine the maximum distance reached.

The Serial1 port on the Arduino Micro board was used to interact with the HC-12 wireless communication module, as Serial1 operates on pins D0 and D1, while the USB port remains dedicated to programming and monitoring via computer.

Figure 2 Arduino Micro board used in the device.



2. The VL53L1X Distance Sensor

The VL53L1X sensor utilizes Time-of-Flight (ToF) technology. It emits an invisible light beam and calculates the time it takes for the signal to return from the opposite surface, thus determining the distance between the sensor and the target. This sensor was chosen because it is suitable for measuring short and medium distances, and its small size makes it easy to install in a handheld device.

Figure 3. Shows the VL53L1X distance sensor used in measuring distance.

3. HC-12 Wireless Communication Module

The HC-12 module was used to wirelessly transmit measurement data from the player device to the receiver module. This module operates using UART serial communication, transmitting data in a simple text format that is easy to receive and analyze.

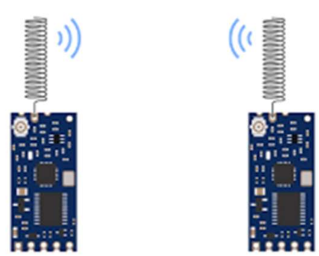
The HC-12 module was connected to an Arduino Micro board using Serial 1. The connection configuration is as follows:

Table 5. shows the connection configuration.

HC-12	Arduino Micro
TX	D0 / RX1
RX	D1 / TX1
VCC	5V
GND	GND

This connection allows sending the final result only after the measurement process is complete, instead of sending continuous readings, in order to reduce delay and improve the device's response during measurement.

Figure 4. HC-12 wireless communication unit.



4.Buzzer

The buzzer was used to provide an audible alert when the sensor reached its highest reading. It was connected to pin D4 of the Arduino Micro board. The buzzer's function is to notify the user that the measurement process has been successfully completed.

The buzzer activates after the highest reading is detected and is unaffected by any subsequent changes in distance. It continues to sound for a specified period and then stops.

Figure 5.The buzzer used to alert when the measurement is complete.

Fifth: Electronic Circuit Connection Method
The device components were connected according to the following table:
Table 6. shows the device connection terminals

Component	Component Pin	Arduino Micro Pin
VL53L1X	VCC / VIN	5V or 3.3V (depending on the module version)
VL53L1X	GND	GND
VL53L1X	SDA	D2 / SDA
VL53L1X	SCL	D3 / SCL
HC-12	TX	D0 / RX1
HC-12	RX	D1 / TX1
HC-12	VCC	5V
HC-12	GND	GND
Buzzer	+	D4
Buzzer	–	GND

Sixth: Mechanical Design and Device Installation
The electronic components are housed within a suitable enclosure or small box to protect the circuitry from movement and vibration. The sensor is positioned so that it points directly towards the ground, as any tilt towards the sensor could lead to an inaccurate reading.
The device is designed to be attached to the player's body using a strap or other suitable fastening device. Attachment near the midsection is preferred to minimize the impact of limb movement on the measurement.
Figure 6. shows the structure used to mount the device components.

VIII. The software processing mechanism within the microcontroller.
The microcontroller is programmed to quickly read the distance from the VL53L1X sensor. The changes in the reading are then analyzed to determine the highest value reached after exceeding one meter.
The algorithm relies on comparing the current reading with the previous reading. If the reading is increasing, the microcontroller updates the current peak value. If the reading begins to decrease after the increase, the highest recorded value is adopted as the final peak.
The final result is calculated as follows:
Highest height after one meter = Highest recorded reading - 1000 mm

Example: If the highest reading reached by the sensor is:
1240 mm
Then the highest height after one meter is:
1240 - 1000 = 240 mm
That is: 0.240 m
Eighth: Wireless Data Format
A simple format was adopted for the transmitted data to facilitate its reception and analysis in the receiver or computer program. The transmission format is as follows:
player1: 240 mm | 0.240 m
This message indicates that the first player has reached a height of 240 mm after exceeding the one-meter mark.
If there is a second player, the data can be transmitted in the following format:
player2: 185 mm | 0.185 m
This format helps to isolate each player's data from the other upon reception.
Ninth: Receiver
The receiver unit receives the data transmitted from the player's device via the HC-12 module. After receiving the message, the text is analyzed to identify the player who sent the data and to extract the height value in millimeters and meters.
The receiver unit receives the data as follows:
player1: 240 mm | 0.240 m
It then displays it on the Serial Monitor or passes it to the computer program designed in C#.
Figure 7. The receiving unit used to receive device data.


Tenth: The Computer Program Designed in C#
A computer program designed in C# to run on the computer. Its function is to receive the jump results and display them digitally and graphically. The program relies on reading the data coming from the serial port, then analyzing the message and extracting the player's name and the height value.
The program receives messages coming from the receiving unit, such as:
player1: 240 mm | 0.240 m
The program then converts the value into a graph and adds it to the player's graph. Thus, the user can view the jump results as a curve or a series of points.
Eleventh: How the C# Program Works
The C# program relies on the following steps:
1. Selecting the appropriate communication port on the computer.
2. Opening the serial connection at an appropriate speed.
3. Receiving the data coming from the HC-12 unit.
4. Analyzing the received text message.
5. Extracting the player's name.
6. Extracting the height value in millimeters and meters. 7. Add the value to the graph.
8. Update the highest recorded value for each player.
The program is designed to display the results of the first and second players separately, allowing for comparison of player performance or tracking of each player's development independently.
Twelfth: The Athlete's Jump Graph
The computer program displays the jump results graphically. The horizontal axis represents the attempt number or reading sequence, while the vertical axis represents the highest height reached by the athlete after exceeding one meter.
Table 7. Shows the significance number and its corresponding axis.

Axis	Description
X-Axis	Trial Number or Measurement Sequence
Y-Axis	Maximum Height (m)
Graph Curve	Change in the Player's Performance Across the Trials

The graph helps analyze a player's performance more clearly than simply reading the numbers. By performing several attempts, it's possible to see whether the player's performance is improving or declining, and to easily identify the best attempt.

Figure 8. Graph of the player's jump results.

Thirteenth: Integration of the Electronic System with the Computer Program

The system is integrated through data transfer between three main stages. The process begins with the player's device, where the distance is measured and the highest value is determined. The result is then wirelessly transmitted using an HC-12 module to the receiving unit. C# software on the computer then reads the data and graphs it.

The practical integration can be summarized as follows:

Player's Device → HC-12 Transmission → Receiving Unit → C# Software → Graphing

Fourteenth: Practical Testing of the Device

The device was tested by moving the sensor vertically up and down, thus changing the distance between the sensor and the ground surface. When the reading increases after exceeding one meter, the system begins tracking the highest value. When the reading begins to decrease, the highest recorded value is used and transmitted to the receiving unit.

The buzzer was also tested to ensure it functions correctly upon completion of the measurement.

The wireless connection was tested to ensure that messages reach the receiving unit correctly.

Fifteenth: Initial Test Results

Initial tests showed that the device is capable of reading the change in distance between the sensor and the ground and extracting the highest value reached by the sensor after exceeding one meter. The wireless transmitter was able to send the result to the receiving unit, and the C# software was able to display the data graphically.

Example of the received result format:

player1: 240 mm | 0.240 m

This means that the highest recorded height after the meter is 240 mm.

Sixteen: Practical Observations During Implementation

During the device's implementation and testing, several important observations emerged, including:

1. The sensor should be pointed towards the ground as vertically as possible.
2. Tilting the device may lead to inaccurate readings.
3. Continuous data transmission may cause a delay in processing; therefore, only the final result was transmitted.
4. Very small changes should be ignored as they may be caused by noise or vibration.
5. Loose device mounting may affect measurement accuracy.
6. The ground surface must be suitable for reflecting the sensor signal.
7. The software helps to understand the results more clearly than a digital display alone.

Resistors (weights)

The scientist (Bernstein) created a table of the relative weights of body parts for men and women, and Table (2) illustrates this (Amhalhal, 2008)

Table 8. shows the relative weights of the parts of the human body

Body Segment	Fischer's Values	Men	Women	Rounded Values
Head	7.06%	6.72%	6.12%	7%

Torso	42.70%	46.30%	43.90%	43%
Thigh	11.58%	12.21%	12.89%	12%
Shank (Lower Leg)	1.79%	4.65%	4.34%	5%
Foot	3.36%	1.46%	1.29%	2%
Upper Arm	2.28%	2.65%	2.60%	3%
Forearm	0.84%	1.82%	1.82%	2%
Hand	0.48%	0.70%	0.55%	1%

Therefore, the use of added weights during training must be carefully considered by determining the correct weight ratios. (Al-Bayati & Al-Fadhli, 2012)
The ratio of the weight carried to each arm or leg is calculated as follows:

- The actual body mass (arm or leg) is derived from its relative mass after determining the actual body mass. For example, let's assume the athlete's body mass is 60 kg, which represents 100%.
- The relative mass of the arm is 6% of the total body mass.
- Therefore, the actual mass of the arm is 3.6 kg.
- The weight added to the arm is 360 grams, which is 10%.
- For the legs, the same steps are followed, keeping in mind that the relative mass of one leg is approximately 19% of the total body mass.

The torso, however, accounts for 43% of the total body mass.

Field Research Procedures

First: Biomechanical Variables

These variables will be extracted through imaging and analysis using the Kenova application during the preparatory phase at maximum knee flexion and the highest point reached by the player during the jump phase at the last touch of the ball. The Kenova motion analysis program works by recording and analyzing movement using advanced techniques, such as video recording and tracking reference points on the body.
The researcher will use the Kenova program to obtain the following variables:

1. Height of the body's center of gravity at maximum knee flexion: This is the measured distance from the hip point (m.S.G.) to the point of contact with the ground during the preparatory phase for the push-off. It was measured at the lowest knee flexion level at the moment of performance. (Robertson, 2021)

Figure 9. Height of the body's center of gravity at maximum knee flexion

2. Height of the body's center of gravity at maximum knee extension: This is the distance measured from the hip point (m.S.G.) to the point of contact with the ground at the highest point reached by the athlete before takeoff. (Robertson, 2021).

Figure 10. Height of the body's center of gravity at maximum knee extension

3. Height of the body's center of gravity (resting point): This is the distance measured from the hip point (m.S.G.) to the point of contact with the ground at the highest point reached by the athlete. (Robertson, 2021).

Figure 11. Height of the body's center of gravity (resting point).

Second: High Jump Shooting Accuracy Test (Qablan, 2012)

Test Objective: To measure the accuracy of high jump shooting.

Equipment Required: Handball court, shooting accuracy squares (40 x 40 cm) representing the four corners of the goal, (12) regulation handballs, high jump apparatus (150 cm), whistle, scoring form, pen.

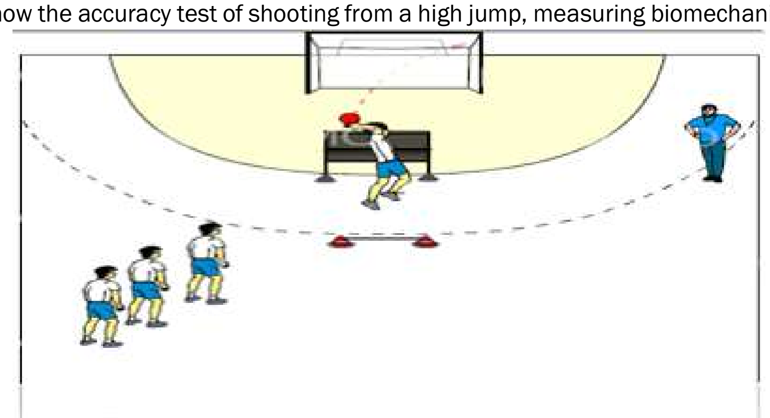
Performance Description: The player stands behind the starting line according to the shooting hand, directly in front of the high jump apparatus post, holding the ball. The player takes (2-3) steps and then performs a high jump shot to square (1), then to (2), then to (3), and then to (4) consecutively. The performance is repeated (3) times, i.e., shooting (12) balls, three of which are to each of the four squares.

Rules: The player must not take more than three steps when shooting from the high jump.

Scoring: A point is awarded when the ball enters the designated shooting square. A shot outside the penalty area is scored zero.

A shot from which the player has moved more than three steps is not counted.

Figure 12 show the accuracy test of shooting from a high jump, measuring biomechanical variables.



First: Measuring Kinematic Variables Using Video Recording

After reviewing scientific sources and references and conducting interviews with experts in the field, the researcher will rely on video recording as it is the appropriate method for analyzing rapid movements that cannot be detected through observation alone. 240 frames per second will be recorded with the assistance of a support team to operate the cameras before the player begins moving. The dimensions and height of the cameras will be determined through preliminary testing.

Two cameras will be used to record the long-range shooting skill test from a high jump using a handball court, as follows:

1- The first camera, positioned 13.30 meters from the center of the performance area at a height of 175 cm, will be used to extract the variables of the highest point of the body's center of gravity.

Exploratory Experiments

Exploratory experiments are a crucial and essential step in any study before proceeding to the main experiment. They are conducted to identify and address the most significant obstacles and drawbacks encountered during the research process. Exploratory experiments are defined as "a survey of the surrounding circumstances of the phenomenon the researcher wishes to study, uncovering any hidden aspects" (Ismail, 2012).

First Exploratory Experiment

The researcher conducted a preliminary exploratory experiment on a randomly selected sample of players from the research population on April 3-4, 2026.

Second Exploratory Experiment

The primary objective of the second exploratory experiment was to implement some exercises developed by the researcher and determine their suitability for the exploratory sample. The researcher coordinated with the coach to conduct a pilot training session with the research sample before commencing the main experiment on April 6, 2026. The purpose of this pilot experiment was to:

- Determine the appropriate weighting percentage.
- Checking the time spent performing the exercises.

Main Experiment

Pre-tests for the Research Sample

- The researcher conducted pre-tests on the research sample on Friday, April 10, 2026.
- The researcher considered the conditions related to the tests, including time, location, tools used, method of implementation, and the support team, in order to ensure their availability for the post-tests. To confirm the increased randomness of the distribution and differences, the researcher determined the equivalence of the sample in the research variables.

Exercise Implementation

- The 35 exercises were distributed throughout the training program over 8 weeks, with 3 sessions per week, resulting in a total of 24 training sessions.
- The training load was undulated (3:1).
- The duration of each exercise session ranged from 30 to 35 minutes.
- The intensity of the exercises was determined by time. The first experimental group was tested wearing weights, while the second experimental group wore both weights and a machine. The maximum time for each exercise was then determined.
- The researcher will use the principle of progressive weighting, applying percentages of body weight to the arms and legs during the training program. The weighting percentage starts at 7% and increases to 10% of the relative body weight. This progression involved consulting scientific sources, conducting interviews with experts in the field, and gathering feedback from trainers, as shown in Table 3.
- The researchers used the principle of distributing weights on parts of the body in both the arms and legs, within the training unit, as this distribution is according to the goal of the exercise, as well as the direct effect on the targeted parts of the body in the exercise itself.
- The second experimental group used the weighting principle while wearing a peak point sensor.

Note: The researcher used the designed device after ensuring its connection to the computer and running the software. The player then wore the device on their waist and began training. The device sent signals that were processed instantly and displayed on the software interface, allowing the player's height to be monitored.

Post-Tests

The researcher conducted post-tests on Friday, June 5, 2026, after completing the training program with weighted exercises and the peak point sensor. The tests focused on specific biomechanical variables and long-range shooting accuracy from a high jump for young handball players. The post-tests were conducted under the same conditions and procedures as the pre-tests, with the assistance of the same support team.

Discussion of Results

Table 9. shows the statistical description of the three groups' sample in terms of biomechanical variables and shooting accuracy in the post-tests.

No.	Variables	Groups	Mean	Standard Deviation	Minimum	Maximum
1	Height of the body mass index (BMI) at Maximum Flexion	Control Group	82.0667	6.444	71.10	91.00
		First Experimental Group	83.7333	7.698	73.00	94.00
		Second Experimental Group	90.8000	5.513	84.00	98.00
2	Height of the body mass index (BMI) at Maximum Extension	Control Group	107.1333	7.49284	100.00	119.90
		First Experimental Group	106.9417	8.153	98.20	120.25
		Second Experimental Group	113.8000	11.492	99.00	126.00
3	Height of the body mass index (BMI) at the Instant of Stillness	Control Group	153.4500	16.57405	136.20	184.70
		First Experimental Group	159.2000	12.498	138.50	170.30
		Second Experimental Group	174.8833	4.775	169.00	180.30
4	Shooting Accuracy	Control Group	3.5000	0.83666	3.00	5.00
		First Experimental Group	6.1667	1.47196	5.00	9.00
		Second Experimental Group	7.8333	1.16905	6.00	9.00

Table 10. shows the source of the variance between biomechanical variables and scoring accuracy in post-tests

No.	Variables	Source of Variance	Sum of Squares	df	Mean Square	Calculated F-value	Sig.	Significance
1	Height of the body mass index (BMI) at Maximum Flexion	Between Groups	257.973	2	128.987	2.949	0.083	Not Significant
		Within Groups	656.007	15	43.734			
2	Height of the body mass index (BMI) at Maximum Extension	Between Groups	1476.834	2	738.417	4.882	0.023	Significant
		Within Groups	2268.563	15	151.238			
3	Height of the body mass index (BMI) at the Instant of	Between Groups	8997.501	2	4498.751	32.654	0.000	Significant
		Within Groups	2066.563	15	137.771			

	Maximum Stillness							
4	Shooting Accuracy	Between Groups	57.333	2	28.667	20.315	0.000	Significant
		Within Groups	21.167	15	1.411			

Table 11. shows the least significant difference (LSD) in biomechanical variables and scoring accuracy in post-tests

No.	Variables	Group Comparison	Mean Difference	Standard Error	Sig. (Calculated)	Significance Level	Statistical Significance
1	Height of the body mass index (BMI) at Maximum Flexion	Control Group – First Experimental Group	1.6667	3.818	0.669	0.05	Not Significant
		Control Group – Second Experimental Group	8.7333	3.818	0.037		Significant
		First Experimental Group – Second Experimental Group	7.0666	3.818	0.084		Not Significant
2	Height of the body mass index (BMI) at Maximum Extension	Control Group – First Experimental Group	5.750	7.100	0.431	0.05	Not Significant
		Control Group – Second Experimental Group	21.433	7.100	0.009		Significant
		First Experimental Group – Second Experimental Group	15.683	7.100	0.043		Significant
3	Height of the body mass index (BMI) at the Instant of Stillness	Control Group – First Experimental Group	34.416	6.776	0.000	0.05	Significant
		Control Group – Second Experimental Group	54.100	6.776	0.000		Significant
		First Experimental Group – Second Experimental Group	19.683	6.776	0.011		Significant

4	Shooting Accuracy	Control Group – First Experimental Group	2.6666	0.6858	0.001	0.05	Significant
		Control Group – Second Experimental Group	4.3333	0.6858	0.000		Significant
		First Experimental Group – Second Experimental Group	1.6666	0.6858	0.001		Significant

First: Discussion of Results Regarding body mass index (BMI) Height at Maximum Flexion

The results of the one-way ANOVA showed no statistically significant differences between the three research groups in the variable of body mass index (BMI) Height at maximum flexion, despite the higher mean of the second experimental group. The calculated F-value was 2.949, which is less than the value required to establish statistical significance at the 0.05 level. The researcher believes that the absence of significant differences between the groups does not necessarily indicate a lack of performance improvement. Rather, it suggests that the degree of improvement between the first and second experimental groups was not sufficient to produce a clear statistical difference, especially since all participants were similar in their technical and physical abilities before the training program, and all groups underwent a standardized training program that differed only in the method of executing the exercises.

The researcher also believes that the maximal flexion phase represents the preparatory stage for the movement and is significantly influenced by the individual characteristics of the players and their technical style more than by muscular strength alone. Therefore, the changes in this variable were limited compared to the other variables. However, the results of the least significant difference (LSD) test showed a significant difference between the control group and the second experimental group, indicating that using weights with the Point Peak machine was more effective than regular training in improving this variable. The difference between the two experimental groups did not reach statistical significance, suggesting that adding the machine improved performance, but not to a large enough degree to produce a clear difference compared to weight training alone.

This aligns with (Khayoun , 2010), who emphasizes that acquiring motor skills and improving their technical phases requires repetition accompanied by accurate feedback, and that some technical variables improve more gradually than physical variables. As (Knudson ,2021) points out, the kinematic variables associated with the pre-stretch phase are influenced by a range of neurological and mechanical factors. Therefore, the magnitude of change in these variables is often smaller than that associated with the push-off and take-off phases.

Secondly: Discussion of the results regarding the height of the body mass index (BMI) **at maximal extension.**

The results of the one-way ANOVA showed differences between the groups in the variable of height of the body mass index (BMI) at maximal extension, with a calculated F-value of 4.882. The LSD test results indicate that the second experimental group outperformed the control group, as well as the first experimental group, while no significant differences were found between the control group and the first experimental group. The researcher believes that this superiority reflects the effectiveness of combining weight training with the use of the Point Peak machine. The weights contributed to developing explosive leg power, while the machine provided real-time feedback that helped the athletes improve the timing of their full extension and utilize the generated power more efficiently.

The researcher also believes that reaching maximum extension represents the crucial stage in producing vertical force; therefore, any improvement in specific strength or performance mechanics is directly reflected in this variable. (Faraj ,2021) confirms that resistance training leads to increased efficiency in speed-strength and improved skill performance. (Bartlett , 2007) explains that the success of the pushing phase depends on the coordination between force production and movement timing, which was achieved more effectively in the second experimental group.

Third: Discussion of Results Regarding body mass index (BMI) Height at Rest

The results of the one-way ANOVA showed statistically significant differences between the research groups in the variable of body mass index (BMI) Height at Rest. The calculated F-value was 32.654, a high value reflecting a clear variance between the training programs used. The LSD test results also showed that the second experimental group outperformed both the first experimental group and the control group, while the first experimental group outperformed the control group.

The researcher believes that this gradual increase in results reflects the cumulative effect of the training program. The first group achieved improvement because of using weights, while the second group achieved greater improvement by combining explosive power development with immediate feedback from the Point Peak device. This led to improved balance during flight and the ability to reach the highest possible altitude while maintaining body stability.

This aligns with (Mahjoub, 2000), who considers body posture control during performance to be a key indicator of skill achievement efficiency. (Lee, 2020) also confirms that immediate feedback improves motor control and reduces errors during performance, which explains the superiority of the second experimental group.

Fourth: Discussion of the research groups' shooting accuracy

The results of the one-way ANOVA showed statistically significant differences between the groups in shooting accuracy, with a calculated F-value of 20.315. The LSD test results showed the second experimental group outperforming the other two groups, while the first experimental group outperformed the control group. This indicates that both training programs were more effective than traditional training, but combining weights with the Point Peak device yielded the best results.

The researcher believes that shooting accuracy represents the result of developments in biomechanical variables. Improvements in body mass index (BMI) elevation, explosive power, and balance during flight have led to better mechanical conditions for shooting. Furthermore, the immediate feedback provided by the device enabled players to continuously correct technical errors, contributing to the consolidation of correct performance and the achievement of the highest levels of accuracy.

This aligns with (Khayoun, 2010), who emphasizes that feedback is one of the most important factors influencing the learning of motor skills and the development of their accuracy. (Knutzen, 2015) also indicates that precise skill performance is the result of the integration of muscular strength, neuromuscular coordination, and correct movement mechanics.

Conclusions

- The standard training program contributed to maintaining performance levels and achieving limited improvement in biomechanical variables and shooting accuracy. However, this improvement did not reach statistical significance.
- Exercises using weights resulted in a significant improvement in the height of the body mass index (BMI) at maximum flexion, maximum extension, and rest, as well as an improvement in the accuracy of long-range shots from the jumping position among young handball players.
- The training program using weights combined with the Point Peak device achieved significant improvements in all the biomechanical variables under study, in addition to the accuracy of long-range shots from the jumping position.
- Using the Point Peak device with weights had a positive effect on enhancing the effectiveness of the training program compared to using weights alone.
- The results of the analysis of variance showed significant differences between the research groups in the variable of height of the body mass index (BMI) at rest, favoring the second experimental group, followed by the first experimental group, and then the control group.
- The least significant difference (LSD) test showed that the second experimental group outperformed the control group in all variables where significant differences were found.
- The results proved that employing assistive devices designed to provide feedback during training contributes to improving biomechanical variables and skill performance more than traditional training or weight training alone.

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Appendix (1)

Exercise Model Used in the Research

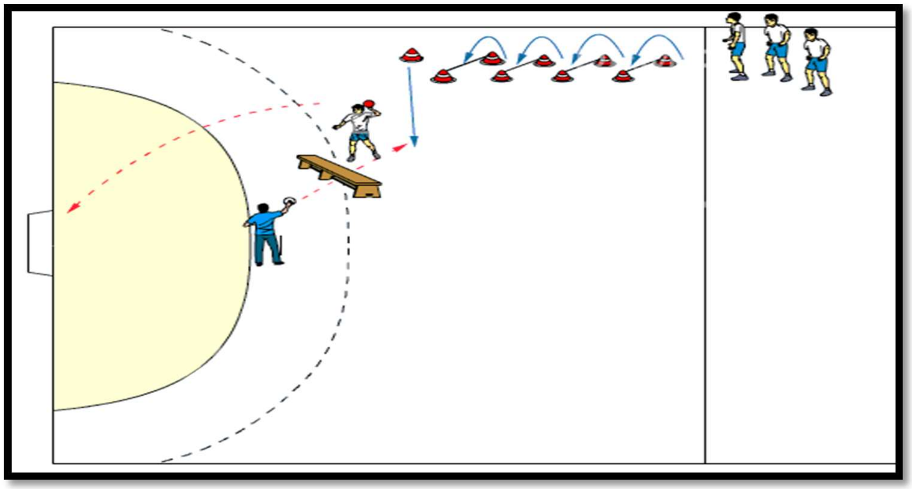
Exercise: (1)

Exercise Objective: To develop the biomechanical variables used and the accuracy of the long-range shooting skill.

Equipment Used: (4) hurdles, (30) cm high, colored spikes, wooden platform, (2) size handballs, whistle, timer, (4) metal squares measuring (40*40) cm.

Performance Method: The players are divided into two groups of (4) players each. Each player from both groups jumps over the top of the four hurdles with both feet. All hurdles are (30) cm high, and the distance between each hurdle is (1) meter. Upon reaching a spike, the player sprints in front of the platform, receives the ball from the coach, takes three steps, and then shoots from the top of the platform at one of the squares located at the top corners of the goal.

Example of Training Units Used in the Research



Training Unit Model Used in the Research
Unit: 1 (Week: 1)
Exercise Time: 32.37 min
Total Exercise Intensity: 85%
Weighting Percentage: 7%
The objective of this training unit is to develop speed-strength and explosive power in the arms and legs, as well as accuracy in shooting from high jumps.

Unit Sections	Exercise Code	Exercise Duration	Number of Repetitions	Rest Between Repetitions	Total Performance Time	Total Rest Time	Total Exercise Time	Transition Time Between Exercises
Part of the Main Section	Ex.1	8 s	5	30 s	40 s	2 min	2 min 40 s	2 min 30 s
	Ex.2	10 s	6	30 s	60 s	2 min 30 s	3 min 30 s	3 min
	Ex.3	8 s	6	30 s	48 s	2 min 30 s	3 min 18 s	3 min
	Ex.4	8 s	5	30 s	40 s	2 min	2 min 40 s	2 min 30 s
	Ex.5	9 s	5	30 s	45 s	2 min	2 min 45 s	3 min
	Ex.6	11 s	4	35 s	44 s	2 min 20 s	3 min 04 s	—