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# DEVELOPMENT AND STANDARDIZATION OF AN ELECTRONIC TEST TO MEASURE MOTOR RESPONSE, SPEED, AND ACCELERATION IN THE SPIKE FOR BACK-ROW VOLLEYBALL PLAYERS

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**Abstract**
Based on the researcher's work in the sports field and specifically in volleyball testing, it was observed that the devices used for volleyball assessments do not measure the specific capacities required by back-row players—such as motor response, speed, and acceleration—using a single device without relying on high-speed cameras and motion analysis. Therefore, this study aimed to design an electronic device to measure motor response, acceleration, and speed during the performance of the spike skill among volleyball players.
To properly address the research problem, the descriptive approach was used, which was deemed the most suitable methodology for this study. The research sample was selected from students of The College of Physical Education and Sports Sciences, comprising 100 fourth-year students.
The researcher developed an electronic device capable of measuring all the investigated capacities, established its scientific foundations, standardized it, and derived its normative criteria.
**Keywords:** (response, acceleration, speed, time, distance)

## Introduction

There has been a remarkable evolution in the technical performances that the sport field has witnessed, thanks to scientific and technological progress and the adoption of modern foundations. (Khalaf, 2022, p. 2). They provide the coach and the player with a clear picture of the achieved level, in addition to evaluating the effectiveness of the methods used in developing physical, skill, and strategic aspects and their contribution to elevating motor performance towards the optimal level (Al-Saadi, 2002, p. 4).From this standpoint, the importance of evaluation tools emerges, as tests and measurements are crucial means for the evaluation process in various fields of life in general, and in the field of physical and sports education in particular, due to the progress they have witnessed in recent years. Tests in the sports field are considered one of the fundamental tools for assessing and understanding performance levels across various sports. Furthermore, "tests represent one of the scientific indicators in research procedures based on scientific foundations. Their importance is evident in providing a clear and real indicator of the training status of a team or player at various stages, whether positive or negative, and revealing any shortcomings if present. This is followed by working to make corrections for subsequent stages. Tests and measurements are among the important means for evaluating the level an athlete has reached" (Al-Ta'i, 2015, p. 32).They also represent "an important tool among scientific research tools, alongside (questionnaires, interviews, and observation). Their use is not confined to educational research only. There are many physical, skill, social, and mental capacities targeted for measurement by tests" (Abdul Zahra, 2011, p. 37).
The great importance of testing is evident across all sports, "which fundamentally rely on a set of capabilities performed at maximal intensity, such as motor response, movement speed, and maximum velocity. This is because tests are linked to the neural structure and muscular work when an individual performs physical exertion within a specific time frame" (Ibrahim, 2012, p. 50). Volleyball is one of the sports that has gained

increasing global attention, driven by its competitive nature, the dynamism of its fundamental skills, and the speed of execution, particularly in performing the spike attack.
The attack skill is one of the most important skill in Volleyball. For a complete understanding of the performance mechanics of this skill, its execution can be divided into four sequential phases: the approach phase, the take-off phase, the hitting phase, and the landing phase.
Through the researcher's experience in volleyball, it was noted that while many testing devices measure most physical and motor abilities, the majority of tests assessing the spike, particularly the back-row spike, focus solely on measuring hitting accuracy. Furthermore, most manufactured devices in this context do not measure the specific capabilities required by back-row players, such as their rapid abilities like motor response, speed, and acceleration, using a single device without resorting to high-speed cameras and motion analysis. Therefore, this study aimed to design an electronic device to measure motor response, acceleration, and speed during the performance of the spike skill in volleyball players.

**Methods and Tools**

The researcher utilized the descriptive approach due to its suitability for the nature of the study (O. A. Ali, 2022; O. Ali & Hamid, 2021; Hammood et al., 2024). The research sample was selected from students of the College of Physical Education and Sports Sciences at the University of Baghdad, consisting of 100 fourth-year students. The sample had a mean age of 22.5 years (±3.45) and a mean height of 171.57 cm (±9.475).
The first step involved designing a prototype model, which was presented to a panel of specialists in testing, volleyball, and biomechanics. Following the incorporation of their feedback, the designs were revised and subsequently delivered to the manufacturing company (SamaUr Technology Company) for production.
Device Components: The device consists of the following parts:
First is the Foot Pressure Sensor which is a spring-loaded switch mechanism, It is a pressure sensor placed at the foot placement position to detect the readiness of the subject. This device calculates motor response time. Secondly is the Trigger Switch which is connected to a start button and features an indicator lamp, that triggers once the start button is pressed. Next is the Start Alarm which activates when the subject presses the start button (which lights up the indicator lamp on the start switch) and presses the foot sensor. After that is Post (1) which is placed 1.5 meters from the starting line and consists of a motion sensor. The subject sets off to pass the first post. Upon passing it, the device calculates the speed using the following equation:

Speed = 1.5 / Time taken to reach the first post

Next is Post (2) which is placed 3 meters from the starting line and consists of a motion sensor. The subject continues running to pass the second post. Upon passing it, the device calculates the speed using the following equation:

Speed = 3 / Time taken to reach the second post.

The device then calculates the acceleration using the following equation:

Acceleration = (Second Speed - First Speed) / Total Time

And lastly Control Box which contains the results display screen.

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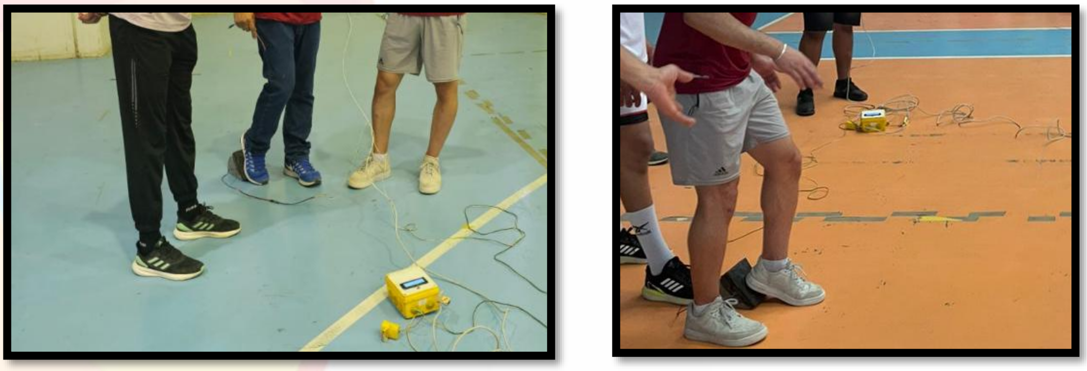

Fig1: Device Components

Fig 2: Test Implementation

After the test were applied, Table (1) shows the statistical coefficients: Mean, Standard Deviation, and Skewness. The skewness coefficient values were confined within (±1), indicating that the test results are normally distributed.

Table (1)
Statistical Data of the Test

| | Test | Mean | Standard Deviation | Skewness |
|---|---|---|---|---|
| 1 | Motor Response (s) | 0.32 | 0.018 | 0.971 |
| 2 | First Speed (m/s) | 5.63 | 0.408 | -0.163 |
| 3 | Second Speed (m/s) | 1.96 | 1.108 | -0.560 |
| 4 | Acceleration (m/s²) | 1.71 | 0.295 | -0.482 |

Scientific Foundations of the Test

After making sure the test was ready, the test was conducted on 43 students. The researcher verified the scientific foundations of the test by distributing a questionnaire form to a panel of 7 experts and specialists to solicit their opinions on the test's validity, with all 7 experts (100%) concurring.

A discriminant validity was also established, which is one of the types of validity, by sorting the test result data from highest to lowest (Al-Kubaisi, 2010, p. 57). Following this, the researcher identified the high and

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low groups, i.e., selected the group with the highest scores and the group with the lowest scores after sorting. The groups were segmented, with the top 27% forming the high group and the bottom 27% forming the low group. Consequently, the number of individuals in the high group reached 12 students, and the low group also had 12 students, while the middle group had 19 students.

Table (2)
Discriminant Validity of the Test

| Test | High Group | | Low Group | | t-value | t-value | Significance |
|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | | | |
| Motor Response (s) | 0.012 | 0.003 | 0.021 | 0.060 | 15.03 | 0.000 | Significant |
| First Speed (m/s) | 3.53 | 0.059 | 6.25 | 0.061 | 32.76 | 0.000 | Significant |
| Second Speed (m/s) | 1.223 | 0.055 | 3.315 | 0.079 | 74.59 | 0.000 | Significant |
| Acceleration (m/s²) | 0.030 | 0.008 | 0.092 | 0.023 | 38.81 | 0.000 | Significant |

Test Reliability
The researcher used the test-retest method to establish the reliability of the test, the retest was re-conducted after six days. The results in Table (3) shows high reliability coefficients, which indicates a statistically significant correlation.

Table (3)
Test Reliability

| | Test | Correlation Coefficient (r) | p-value | Significance |
|---|---|---|---|---|
| 1 | Motor Response (s) | 0.543 | 0.000 | Significant |
| 2 | First Speed (m/s) | 0.799 | 0.000 | Significant |
| 3 | Second Speed (m/s) | 0.654 | 0.000 | Significant |
| 4 | Acceleration (m/s²) | 0.882 | 0.000 | Significant |

Final Test Specifications
- Purpose of the Test: To measure motor response time, speed, and acceleration.
- Target Population: Students of the College of Physical Education and Sports Sciences.
- Equipment Used: Volleyball court, motor response, speed, and acceleration measurement device.
- Test Procedure:
  - The subject stands on the start switch, awaiting the "ready" command followed by the start signal from the test administrator.
  - The administrator presses the start button, which triggers the device's start buzzer.
  - Upon hearing the buzzer, the subject sprints forward to cover the first distance of 2 meters, passing the first sensor.
  - After the subject passes the first sensor, the device activates a second buzzer.
  - The subject continues sprinting rapidly towards the second sensor.
  - Upon reaching the second sensor, the device activates a third buzzer, signaling the end of the test.
- Data Recorded: The device automatically records the motor response time, first speed, second speed, acceleration, and the total performance time.

**Research Results**

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The researcher applied the main experiment to the main study sample, which consisted of 57 students. The research results are presented as follows:

Table (4)
Raw Scores, Z-Scores, and T-Scores for the Motor Response Test

| | Raw Scores | Z-Scores | T-Scores | | Raw Scores | Z-Scores | T-Scores |
|---|---|---|---|---|---|---|---|
| 1 | 0.096 | -2.49536- | 25.05 | 30 | 0.046 | 0.30676 | 53.07 |
| 2 | 0.095 | -2.43931- | 25.61 | 31 | 0.046 | 0.30676 | 53.07 |
| 3 | 0.089 | -2.10306- | 28.97 | 32 | 0.046 | 0.30676 | 53.07 |
| 4 | 0.086 | -1.93493- | 30.65 | 33 | 0.046 | 0.30676 | 53.07 |
| 5 | 0.085 | -1.87889- | 31.21 | 34 | 0.046 | 0.30676 | 53.07 |
| 6 | 0.085 | -1.87889- | 31.21 | 35 | 0.046 | 0.30676 | 53.07 |
| 7 | 0.075 | -1.31847- | 36.82 | 36 | 0.045 | 0.3628 | 53.63 |
| 8 | 0.075 | -1.31847- | 36.82 | 37 | 0.045 | 0.3628 | 53.63 |
| 9 | 0.075 | -1.31847- | 36.82 | 38 | 0.045 | 0.3628 | 53.63 |
| 10 | 0.07 | -1.03826- | 39.62 | 39 | 0.04 | 0.64301 | 56.43 |
| 11 | 0.065 | -.75805- | 42.42 | 40 | 0.04 | 0.64301 | 56.43 |
| 12 | 0.065 | -.75805- | 42.42 | 41 | 0.036 | 0.86718 | 58.67 |
| 13 | 0.065 | -.75805- | 42.42 | 42 | 0.036 | 0.86718 | 58.67 |
| 14 | 0.065 | -.75805- | 42.42 | 43 | 0.035 | 0.92322 | 59.23 |
| 15 | 0.065 | -.75805- | 42.42 | 44 | 0.035 | 0.92322 | 59.23 |
| 16 | 0.057 | -.30971- | 46.9 | 45 | 0.035 | 0.92322 | 59.23 |
| 17 | 0.056 | -.25367- | 47.46 | 46 | 0.035 | 0.92322 | 59.23 |
| 18 | 0.056 | -.25367- | 47.46 | 47 | 0.033 | 1.03531 | 60.35 |
| 19 | 0.056 | -.25367- | 47.46 | 48 | 0.033 | 1.03531 | 60.35 |
| 20 | 0.055 | -.19762- | 48.02 | 49 | 0.033 | 1.03531 | 60.35 |
| 21 | 0.054 | -.14158- | 48.58 | 50 | 0.033 | 1.03531 | 60.35 |
| 22 | 0.053 | -.08554- | 49.14 | 51 | 0.033 | 1.03531 | 60.35 |
| 23 | 0.049 | 0.13863 | 51.39 | 52 | 0.033 | 1.03531 | 60.35 |
| 24 | 0.046 | 0.30676 | 53.07 | 53 | 0.033 | 1.03531 | 60.35 |
| 25 | 0.046 | 0.30676 | 53.07 | 54 | 0.033 | 1.03531 | 60.35 |
| 26 | 0.046 | 0.30676 | 53.07 | 55 | 0.033 | 1.03531 | 60.35 |
| 27 | 0.046 | 0.30676 | 53.07 | 56 | 0.033 | 1.03531 | 60.35 |
| 28 | 0.046 | 0.30676 | 53.07 | 57 | 0.033 | 1.03531 | 60.35 |
| 29 | 0.046 | 0.30676 | 53.07 | | | | |

Table (5)
Raw Scores, Z-Scores, and T-Scores for the 1.5 Meter Speed Test

| | Raw Scores | Z-Scores | T-Scores | | Raw Scores | Z-Scores | T-Scores |
|---|---|---|---|---|---|---|---|
| 1 | 2.045 | -2.17945- | 28.21 | 30 | 2.956 | 0.05385 | 50.54 |
| 2 | 2.104 | -2.03481- | 29.65 | 31 | 3.015 | 0.19848 | 51.98 |
| 3 | 2.108 | -2.02501- | 29.75 | 32 | 3.04 | 0.25977 | 52.6 |

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|---|---|---|---|---|---|---|---|
| 4 | 2.145 | -1.93430- | 30.66 | 33 | 3.04 | 0.25977 | 52.6 |
| 5 | 2.356 | -1.41704- | 35.83 | 34 | 3.045 | 0.27203 | 52.72 |
| 6 | 2.356 | -1.41704- | 35.83 | 35 | 3.051 | 0.28674 | 52.87 |
| 7 | 2.412 | -1.27976- | 37.2 | 36 | 3.051 | 0.28674 | 52.87 |
| 8 | 2.458 | -1.16699- | 38.33 | 37 | 3.051 | 0.28674 | 52.87 |
| 9 | 2.487 | -1.09590- | 39.04 | 38 | 3.109 | 0.42892 | 54.29 |
| 10 | 2.562 | -.91204- | 40.88 | 39 | 3.109 | 0.42892 | 54.29 |
| 11 | 2.612 | -.78946- | 42.11 | 40 | 3.109 | 0.42892 | 54.29 |
| 12 | 2.633 | -.73798- | 42.62 | 41 | 3.109 | 0.42892 | 54.29 |
| 13 | 2.712 | -.54431- | 44.56 | 42 | 3.109 | 0.42892 | 54.29 |
| 14 | 2.384 | -1.34840- | 36.52 | 43 | 3.109 | 0.42892 | 54.29 |
| 15 | 2.741 | -.47322- | 45.27 | 44 | 3.109 | 0.42892 | 54.29 |
| 16 | 2.779 | -.38007- | 46.2 | 45 | 3.109 | 0.42892 | 54.29 |
| 17 | 2.817 | -.28691- | 47.13 | 46 | 3.109 | 0.42892 | 54.29 |
| 18 | 2.817 | -.28691- | 47.13 | 47 | 3.245 | 0.76232 | 57.62 |
| 19 | 2.856 | -.19130- | 48.09 | 48 | 3.25 | 0.77458 | 57.75 |
| 20 | 2.856 | -.19130- | 48.09 | 49 | 3.412 | 1.17172 | 61.72 |
| 21 | 2.896 | -.09324- | 49.07 | 50 | 3.45 | 1.26488 | 62.65 |
| 22 | 2.896 | -.09324- | 49.07 | 51 | 3.452 | 1.26978 | 62.7 |
| 23 | 2.896 | -.09324- | 49.07 | 52 | 3.54 | 1.48551 | 64.86 |
| 24 | 2.896 | -.09324- | 49.07 | 53 | 3.564 | 1.54435 | 65.44 |
| 25 | 2.896 | -.09324- | 49.07 | 54 | 3.569 | 1.5566 | 65.57 |
| 26 | 2.896 | -.09324- | 49.07 | 55 | 3.652 | 1.76008 | 67.6 |
| 27 | 2.896 | -.09324- | 49.07 | 56 | 3.658 | 1.77478 | 67.75 |
| 28 | 2.926 | -.01970- | 49.8 | 57 | 3.854 | 2.25527 | 72.55 |
| 29 | 2.926 | -.01970- | 49.8 | | | | |

Table (6)
Raw Scores, Z-Scores, and T-Scores for the 3 Meter Speed Test

| | Raw Scores | Z-Scores | T-Scores | | Raw Scores | Z-Scores | T-Scores |
|---|---|---|---|---|---|---|---|
| 1 | 3.25 | -1.78950- | 32.1 | 30 | 5.828 | 0.53809 | 55.38 |
| 2 | 3.412 | -1.64324- | 33.57 | 31 | 5.875 | 0.58053 | 55.81 |
| 3 | 3.45 | -1.60893- | 33.91 | 32 | 5.875 | 0.58053 | 55.81 |
| 4 | 3.452 | -1.60712- | 33.93 | 33 | 5.875 | 0.58053 | 55.81 |
| 5 | 3.54 | -1.52767- | 34.72 | 34 | 5.875 | 0.58053 | 55.81 |
| 6 | 3.564 | -1.50600- | 34.94 | 35 | 5.875 | 0.58053 | 55.81 |
| 7 | 3.569 | -1.50149- | 34.99 | 36 | 5.879 | 0.58414 | 55.84 |
| 8 | 3.569 | -1.50149- | 34.99 | 37 | 5.895 | 0.59859 | 55.99 |
| 9 | 3.589 | -1.48343- | 35.17 | 38 | 5.896 | 0.59949 | 55.99 |
| 10 | 3.652 | -1.42655- | 35.73 | 39 | 5.938 | 0.63741 | 56.37 |
| 11 | 3.658 | -1.42113- | 35.79 | 40 | 5.938 | 0.63741 | 56.37 |
| 12 | 3.854 | -1.24417- | 37.56 | 41 | 5.938 | 0.63741 | 56.37 |

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|---|---|---|---|---|---|---|---|
| 13 | 3.893 | -1.20896- | 37.91 | 42 | 5.938 | 0.63741 | 56.37 |
| 14 | 3.952 | -1.15569- | 38.44 | 43 | 5.968 | 0.6645 | 56.64 |
| 15 | 3.956 | -1.15208- | 38.48 | 44 | 6.017 | 0.70874 | 57.09 |
| 16 | 3.989 | -1.12228- | 38.78 | 45 | 6.017 | 0.70874 | 57.09 |
| 17 | 4.258 | -.87941- | 41.21 | 46 | 6.017 | 0.70874 | 57.09 |
| 18 | 4.576 | -.59230- | 44.08 | 47 | 6.135 | 0.81528 | 58.15 |
| 19 | 4.589 | -.58056- | 44.19 | 48 | 6.135 | 0.81528 | 58.15 |
| 20 | 5.012 | -.19865- | 48.01 | 49 | 6.211 | 0.88389 | 58.84 |
| 21 | 5.024 | -.18781- | 48.12 | 50 | 6.211 | 0.88389 | 58.84 |
| 22 | 5.236 | 0.0036 | 50.04 | 51 | 6.211 | 0.88389 | 58.84 |
| 23 | 5.62 | 0.3503 | 53.5 | 52 | 6.211 | 0.88389 | 58.84 |
| 24 | 5.642 | 0.37016 | 53.7 | 53 | 6.211 | 0.88389 | 58.84 |
| 25 | 5.689 | 0.4126 | 54.13 | 54 | 6.739 | 1.36061 | 63.61 |
| 26 | 5.698 | 0.42072 | 54.21 | 55 | 6.793 | 1.40936 | 64.09 |
| 27 | 5.789 | 0.50288 | 55.03 | 56 | 6.793 | 1.40936 | 64.09 |
| 28 | 5.828 | 0.53809 | 55.38 | 57 | 6.793 | 1.40936 | 64.09 |
| 29 | 5.828 | 0.53809 | 55.38 | | | | |

Table (7)
Raw Scores, Z-Scores, and T-Scores for the Acceleration Test

| | Raw Scores | Z-Scores | T-Scores | | Raw Scores | Z-Scores | T-Scores |
|---|---|---|---|---|---|---|---|
| 1 | 0.218 | -1.52378- | 34.76 | 30 | 0.843 | 0.5958 | 55.96 |
| 2 | 0.246 | -1.42882- | 35.71 | 31 | 0.851 | 0.62294 | 56.23 |
| 3 | 0.255 | -1.39830- | 36.02 | 32 | 0.847 | 0.60937 | 56.09 |
| 4 | 0.25 | -1.41526- | 35.85 | 33 | 0.847 | 0.60937 | 56.09 |
| 5 | 0.239 | -1.45256- | 35.47 | 34 | 0.846 | 0.60598 | 56.06 |
| 6 | 0.245 | -1.43222- | 35.68 | 35 | 0.845 | 0.60259 | 56.03 |
| 7 | 0.237 | -1.45935- | 35.41 | 36 | 0.847 | 0.60937 | 56.09 |
| 8 | 0.23 | -1.48309- | 35.17 | 37 | 0.853 | 0.62972 | 56.3 |
| 9 | 0.23 | -1.48309- | 35.17 | 38 | 0.843 | 0.5958 | 55.96 |
| 10 | 0.232 | -1.47630- | 35.24 | 39 | 0.859 | 0.65007 | 56.5 |
| 11 | 0.225 | -1.50004- | 35 | 40 | 0.859 | 0.65007 | 56.5 |
| 12 | 0.272 | -1.34065- | 36.59 | 41 | 0.859 | 0.65007 | 56.5 |
| 13 | 0.268 | -1.35422- | 36.46 | 42 | 0.859 | 0.65007 | 56.5 |
| 14 | 0.339 | -1.11343- | 38.87 | 43 | 0.871 | 0.69076 | 56.91 |
| 15 | 0.279 | -1.31691- | 36.83 | 44 | 0.889 | 0.75181 | 57.52 |
| 16 | 0.281 | -1.31013- | 36.9 | 45 | 0.889 | 0.75181 | 57.52 |
| 17 | 0.349 | -1.07952- | 39.2 | 46 | 0.889 | 0.75181 | 57.52 |
| 18 | 0.444 | -.75734- | 42.43 | 47 | 0.911 | 0.82642 | 58.26 |

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|---|---|---|---|---|---|---|---|
| 19 | 0.441 | -.76751- | 42.32 | 48 | 0.911 | 0.82642 | 58.26 |
| 20 | 0.576 | -.30968- | 46.9 | 49 | 0.91 | 0.82302 | 58.23 |
| 21 | 0.572 | -.32325- | 46.77 | 50 | 0.902 | 0.79589 | 57.96 |
| 22 | 0.643 | -.08246- | 49.18 | 51 | 0.902 | 0.79589 | 57.96 |
| 23 | 0.777 | 0.37198 | 53.72 | 52 | 0.884 | 0.73485 | 57.35 |
| 24 | 0.785 | 0.39911 | 53.99 | 53 | 0.879 | 0.71789 | 57.18 |
| 25 | 0.802 | 0.45676 | 54.57 | 54 | 1.099 | 1.46399 | 64.64 |
| 26 | 0.805 | 0.46693 | 54.67 | 55 | 1.106 | 1.48773 | 64.88 |
| 27 | 0.838 | 0.57885 | 55.79 | 56 | 1.104 | 1.48094 | 64.81 |
| 28 | 0.847 | 0.60937 | 56.09 | 57 | 1.061 | 1.33512 | 63.35 |
| 29 | 0.847 | 0.60937 | 56.09 | | | | |

standards Levels
Obtaining raw scores is the initial step in establishing norms and standards. These scores, in themselves, are meaningless unless compared against established criteria or levels that allow an individual to understand their standing relative to peers and to form a final judgment. As Al-Mandalawi (1989, p. 31) states, "The raw scores derived from test applications have no significance or meaning unless referenced against a standard that defines the meaning of these scores."
In accordance with this, the raw scores obtained from administering the tests for motor response, speed, and acceleration were converted to standardized T-scores using the successive intervals method, as shown in the following table:

Table (8)
Normative Levels for Motor Response Test

| Normative Levels | Raw Score Lower Limit | Raw Score Upper Limit |
|---|---|---|
| Excellent | 0.096 | 0.1065 |
| Very Good | 0.1165 | 0.127 |
| Good | 0.137 | 0.1475 |
| Average | 0.1575 | 0.168 |
| Poor | 0.178 | 0.1885 |
| Very Poor | 0.1985 | 0.209 |

Table (9)
Normative Levels for 1.5 Meter Speed Test

| Normative Levels | Raw Score Lower Limit | Raw Score Upper Limit |
|---|---|---|
| Excellent | 2.045 | 2.0555 |
| Very Good | 2.0655 | 2.076 |
| Good | 2.086 | 2.0965 |
| Average | 2.1065 | 2.117 |
| Poor | 2.127 | 2.1375 |
| Very Poor | 2.1475 | 2.158 |

**Discussion of Results**

To establish normative levels for the research variables, the researcher employed the Gaussian normal distribution method, which "is one of the most common distributions in the field of Physical Education because the distribution of many of the qualities and characteristics measured in this field approximates the normal curve."

The normative levels were constructed based on the percentile distribution of cases lying between the standard scores of the normal distribution, in which 99.73% of cases fall within the limits of three positive and three negative standard deviations. Six levels were chosen, and accordingly, there is one standard deviation between each level and the next (6/6).

The technical phases of the back-row spike skill are characterized by rapid sequencing. The initial phase is crucial in the process of advancing to perform the skill, followed by the launch phase, which is also important for rapid advancement and relies on reaction, speed, and motor response after the player pushes off the ground with maximum speed and power upon seeing the ball. Many players lose a significant portion of their time at this moment (the launch moment) due to weak motor response; therefore, it is essential to focus on developing reaction speed through specialized exercises.

Motor response represents a type of rapid muscular action linked to neural processes (sensory and motor), which are of great importance in volleyball. It consists of the speed of motor reaction, which is "the time duration between the occurrence of a stimulus and the beginning of the motor response to that stimulus" (Gábo, 2015, p. 9) and represents "the time duration between the command and the movement" (Ghosh, 2010, p. 11). It is also defined as the ability to produce a simple motor response to a specific stimulus in the shortest possible time. In other words, it is the speed of an individual's response to a stimulus with a voluntary reaction(Fayyad et al., 2025; Khalaf et al., 2025).

Furthermore, the technical phases of performing a spike in volleyball are characterized by the presence of an acceleration phase. This phase represents a period of increasing speed, starting from the moment of launch from a stationary position until the player reaches the appropriate speed for the spike. The mechanical concept of increasing speed is acceleration, which occurs gradually as the player transitions from rest, with an initial velocity of zero, by applying a force that changes the state of the body to motion (Newton's First Law). (Al-Fadhli and Al-Bayati, 2012)

As for speed, it is defined as "the ability to perform specific movements in the shortest possible time" (Abdul Hassan, 2011, p. 95). It is also defined as "the individual's ability to perform successive movements of the same type in the shortest duration" (Hamdan and Abdul Razzaq, 2001). Speed is further defined as "the ability to perform specific movements in the least possible time" (Hammadi, 1998, p. 191).

From a biological perspective, speed means "physiological processes and muscular excitations that appear in a short time and generate energy and neural impulses. These excitations are linked to human potential; the speed of muscle excitation and the degree of contraction in the body's tissues grant the athlete the required speed." (Brandenburg & Docherty, 2002, p. 8)

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