

# Test and Research on Perception Index Based on Calculation Statistics and Sensing Technology

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**Abstract.** Since the 21st century, China's ministry of education releases the standards of sports teaching. In this situation sports teaching reform has produced the breakthrough in our country, and this makes all kinds of sports have vigorous development. The volleyball sports occupy a very important position in our country. This article is based on the volleyball spiking technique to analyze all kinds of action in the process of spiking movement, and it can conjecture the influence of a variety of sports perceptions' indexes in the process of spiking movement. Then this paper carries on the design of the test, and establishes an analytical statement of the influencing factors in the process of volleyball spiking movement, and it gets the principle of field test to record the motion parameters in the process of volleyball players' spiking movement. Finally it has the mathematical statistical analysis on the test results, and it uses the t test to have probability analysis on the operation parameters in the process of volleyball movement, and then it obtains the importance of sports perceptions' indexes in the process of spiking movement. The test results show that in the volleyball spiking movement, the run-up distance, minimum height, lifting height and spiking time have great influence on the volleyball spiking movement.

## Introduction

Volleyball is one of the most popular sports in the world. The volleyball sports need the players to have some basic and high ability of the special skills, and especially the drop shot is the most difficult to be mastered. Volleyball athletes should have the greatest strength and high accuracy and approximate peak to jump up to hit the volleyball[1]. In the last few years of the 20th century, the research emphases of volleyball sports skills have been transferred to athletes' perceptions of volleyball.

In 1982 Prsala determined the four stages of the volleyball spiking skill, they were the goal setting, batting preparation, aggressive batting and safe landing. The goal setting includes the run-up and leap forward of two or three control steps, and then it has a transitional and final stop to transfer the horizontal motion's momentum to the preparation of vertical movement's momentum[2]. At last it is the vertical leap of the feet. In the preparation stage of batting, the arms need large upswing to promote the body's transverse rotation at the same time, and the arms should be bent almost 90-degrees and extended elbow attack. In the period of aggressive batting, the player has to raise their shoulders, and the arms have internal rotation and knockout, and then the players flex their elbows and wrists to hit the volleyball to the opposite side. Finally it is the landing stage, and volleyball athletes absorb the potential energy of the curved joint and the lower limbs when they have the downward landing, in this way they can have the safe and stable landing[3].

Coleman (1993) studied the smash skills of the top ten men in the men's volleyball of world university games in 1991[4]. Through the study we can find that in the case of athlete's average quality (COM), the speed of volleyball players' vertical takeoff is about 3.59 m/s, and the jumping height is about 0.62m. Saunder (1980) studied the influence of running speed on the height of vertical bounce in the process of run-up. Through the research it can be found that when the volleyball player's largest minimum height is 2 feet, the speed of run-up is 60% - 70% of the dash speed. When the volleyball players' maximum minimum height is one foot, the speed of run-up is 50% - 60% of the dash speed. In the volleyball smash movement's skills, it is very important to

understand and master these skilled actions, and it can greatly improve the success rate of spiking movement[5]. The purpose of this study is to analyze some factors' influence on the spiking movement in the process of volleyball movement, such as the distance of run-up, the speed of run-up, the speed of vertical takeoff, the average weight of the athletes, height of spiking movement, angle and the time of athletes' spiking movements and so on, and this paper also has the research of these factors' influence on the volleyball movement's scores[6].

(a. preparation of takeoff; b. rise the arms; c. flex the arms and elbows; d. aggressive batting; e. homeopathic falling; f. safe landing)

## Research on sports perceptions' indexes of the volleyball athletes

### A. Test object

The eight male athletes of physical education major's volleyball team in the key university were selected as the test object. Before the test, it had the statistics of eight volleyball players' features, and the average age, height, and weight are shown in Table 1.

TABLE I. AGE, HEIGHT, AND WEIGHT OF TEST OBJECT (N=8)

| Parameters    | Minimum value | maximum value | Average value + deviation |
|---------------|---------------|---------------|---------------------------|
| <i>Age</i>    | 18.00         | 26.00         | 23.00±2.00                |
| <i>Height</i> | 186.00        | 194.00        | 189.00±0.05               |
| <i>Weight</i> | 58.78         | 79.81         | 68.00±6.54                |

TABLE II. THE T TEST CAN PROVIDE THE STANDARD VALUE TO EVALUATE THE DIFFERENCE OF THE TARGETS, AND THIS CAN JUDGE THE INCIDENCE OF ALL KINDS OF INFLUENCING FACTORS. AND T TEST IS VERY HELPFUL TO TEST THE DATA STATISTICS. LOG SHEET OF EIGHT ATHLETES' MOTION PARAMETERS IN SPIKING MOVEMENT

| Serial number | Spiking skills | Distance of run-up (m) | Speed of run-up (m/s) | Vertical take-off speed (m/s) | Spiking time (s) | Lifting Height (m) | Maximum height (m) |
|---------------|----------------|------------------------|-----------------------|-------------------------------|------------------|--------------------|--------------------|
| 1             | <i>Short</i>   | 3.15                   | 3.53                  | 2.23                          | 0.34             | 1.24               | 3.72               |
|               | <i>High</i>    | 3.56                   | 3.34                  | 2.88                          | 0.34             | 1.42               | 3.87               |
| 2             | <i>Short</i>   | 3.74                   | 3.44                  | 3.60                          | 0.37             | 1.04               | 3.75               |
|               | <i>High</i>    | 4.36                   | 3.45                  | 2.16                          | 0.35             | 1.45               | 3.54               |
| 3             | <i>Short</i>   | 3.86                   | 4.01                  | 2.16                          | 0.34             | 1.52               | 3.07               |
|               | <i>High</i>    | 4.14                   | 3.01                  | 2.16                          | 0.36             | 1.21               | 4.75               |
| 4             | <i>Short</i>   | 3.35                   | 3.65                  | 3.60                          | 0.29             | 1.24               | 3.75               |
|               | <i>High</i>    | 3.75                   | 3.55                  | 4.32                          | 0.35             | 1.54               | 3.57               |
| 5             | <i>Short</i>   | 3.38                   | 4.57                  | 3.60                          | 0.25             | 1.35               | 3.57               |
|               | <i>High</i>    | 4.25                   | 4.14                  | 4.76                          | 0.35             | 1.54               | 3.75               |
| 6             | <i>Short</i>   | 3.03                   | 3.72                  | 4.32                          | 0.23             | 1.57               | 3.67               |
|               | <i>High</i>    | 3.70                   | 2.68                  | 5.04                          | 0.75             | 1.75               | 3.78               |
| 7             | <i>Short</i>   | 3.14                   | 3.52                  | 4.35                          | 0.57             | 0.95               | 3.54               |
|               | <i>High</i>    | 3.73                   | 2.37                  | 3.65                          | 0.75             | 1.54               | 3.57               |
| 8             | <i>Short</i>   | 3.56                   | 3.87                  | 2.87                          | 0.35             | 1.54               | 3.74               |
|               | <i>High</i>    | 3.42                   | 2.56                  | 4.31                          | 0.54             | 1.45               | 3.45               |

### B. Test method

Test's arrangement diagram is shown in Figure 2. The video camera that had 24 frames per second to record the imagery was placed in front of volleyball players' spiking area, and every test athlete had 5 groups of short-range smash and 5 groups of high-range spiking movement, and it used the camera to record all of their actions.

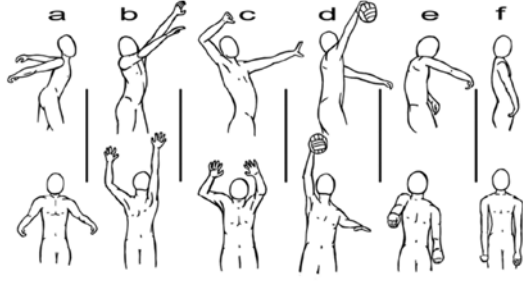


Figure 1. Schematic diagram of batting in the process of volleyball movement

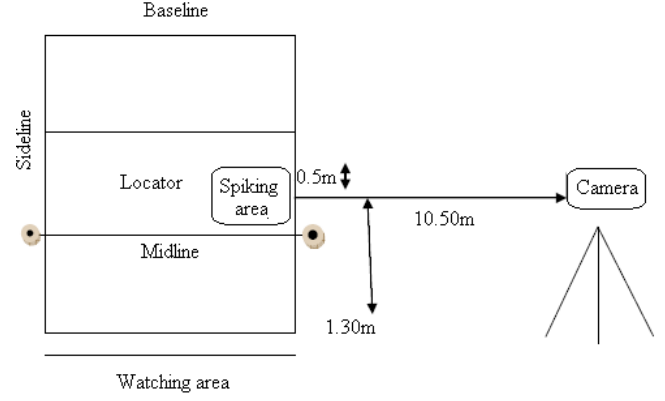


Figure 2. Arrangement diagram of test

The test settings are shown in Table 2. The motion characteristics of successful smash are analyzed and record in Table 2, and the data is used to analyze each indicator's affected parameters of the spiking movement. The distance of run-up, the speed of run-up, the speed of takeoff, the height of lifting arms, the height of minimum height and the duration were recorded as parameters.

## Principles of statistics

### A. Basis of statistics

$X_1, X_2, \dots, X_n$  are set as the sample of the totality  $X$ , and  $x_1, x_2, \dots, x_n$  are the sample

$$\bar{X} = \frac{1}{n} \sum_{i=1}^n X_i \quad (1)$$

observations, and then there has:

(1) The sample mean[7]:

It is often used as the estimator of overall expectations (average value), the observed value is[8]:

$$\bar{x} = \frac{1}{n} \sum_{i=1}^n x_i \quad (2)$$

$$(2) \text{ Sample variance}[9] \quad S^2 = \frac{1}{n-1} \sum_{i=1}^n (X_i - \bar{X})^2 = \frac{1}{n-1} \left( \sum_{i=1}^n X_i^2 - n\bar{X}^2 \right) \quad (3)$$

$$(3) \text{ Standard deviation of sample} \quad S = \sqrt{S^2} \quad (4)$$

Sample variance and standard deviation express the sample data's dispersion degree, and they are often used as the estimator of population variance and standard deviation, the observed values of them respectively are[10]:

$$s^2 = \frac{1}{n-1} \sum_{i=1}^n (x_i - \bar{x})^2 \quad (5) \quad s = \sqrt{s^2} = \sqrt{\frac{1}{n-1} \sum_{i=1}^n (x_i - \bar{x})^2} \quad (6)$$

$$(4) \text{ Sample k-order origin moment} \quad A_k = \frac{1}{n} \sum_{i=1}^n X_i^k, \quad K=1,2,3,\dots \quad (7)$$

$$(5) \text{ Sample k-order central moment} \quad B_k = \frac{1}{n} \sum_{i=1}^n (X_i - \bar{X})^k \quad (8)$$

$$\text{Obviously there has}[11]: A_1 = \bar{X} \quad (9) \quad B_2 = \frac{1}{n} \sum_{i=1}^n (X_i - \bar{X})^2 \quad (10)$$

The observed values of  $A_k$  and  $B_k$  respectively are[12]:

$$a_k = \frac{1}{n} \sum_{i=1}^n x_i^k \quad (11) \quad b_k = \frac{1}{n} \sum_{i=1}^n (x_i - \bar{x})^k \quad (12)$$

### B. The basic principle of t test

The t test uses the t distribution theory to determine the probability of sample's occurred differences, and this can judge the significant difference of the sample. The principle of t test is[13]:

$$t = \frac{\bar{X} - \bar{x}}{\frac{s}{\sqrt{n-1}}} \quad (13)$$

TABLE III. IMPORTANCE DEGREE OF THE MOTION PARAMETERS IN SHORT-RANGE SMASH AND HIGH-RANGE SMASH (N = 8)

| Indicators                                   | Short-range smash<br>S.D mid-value |       | High-range smash<br>S.D mid-value |       | Estimation of t value | P value | Evaluation    |
|--|------------------------------------|-------|-----------------------------------|-------|-----------------------|---------|---------------|
| <i>Distance of run-up</i><br>( <i>m</i> )    | 3.32                               | ±0.54 | 3.85                              | ±0.40 | 2.50                  | 0.054   | Important     |
| <i>Speed of run-up</i><br>( <i>m / s</i> )   | 3.24                               | ±0.75 | 3.14                              | ±0.40 | 1.71                  | 0.454   | Not important |
| <i>Speed of take-off</i><br>( <i>m / s</i> ) | 3.24                               | ±0.75 | 3.41                              | ±1.54 | 0.75                  | 0.375   | Not important |
| <i>Spiking time</i><br>( <i>s</i> )          | 0.32                               | ±0.05 | 0.34                              | ±0.15 | 3.17                  | 0.034   | Important     |
| <i>Lifting height</i> ( <i>m</i> )           | 1.11                               | ±0.15 | 1.50                              | ±0.78 | 2.21                  | 0.024   | Important     |
| <i>Maximum height</i> ( <i>m</i> )           | 3.74                               | ±0.17 | 3.27                              | ±0.14 | 7.74                  | 0.001   | Important     |

### Analysis of test results

Table 2 chooses the motion parameters of eight volleyball athletes in the process of short-range smash and high-range spiking movement, and this can provide basis for the subsequent statistical analysis.

From Table 2 we can see that run-up distance of high-range smash is significantly greater than run-up distance of short-range smash. It uses the t test to have further analysis on the size of indicators' influencing factors in the process of volleyball smash motion, and the analytical results are shown in Table 3.

From Table 3 it can be clearly seen that in statistical sense, the biggest influencing factors of improving the ability of short-range smash and high-range smash are the distance of run-up, lifting height, minimum height. Average differences of the speed of run-up and speed of take-off are smaller, and they have smaller effect on the results.

### Conclusion

According to the experimental results, we can get the following conclusions:

(1) In the smash movement, the run-up speed has big influence on the short-range smash, and height smash should pay attention to the distance of run-up.

(2) In process of high-range smash, its lifting height is higher than short-range smash's lifting height.

(3) The spiking time of high-range smash is less than that of short-range smash.

(4) According to the analysis, we can conclude that in process of volleyball smash movement, the influence of run-up distance, minimum height, spiking time, lifting height and the maximum height on the smash movement is very important.

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