Causes of Sports Injury of Badminton Players and Design of Forecasting Models

Jianguo Zhu
Nanjing Sport Institute, Nanjing 210014, China
402160683@qq.com

Abstract
Badminton is a kind of anti-allergic movement with a high incidence of injury. The sports injury brings great troubles to the participants, affecting the participants’ enthusiasm for sports, and is not conducive to the healthy development of badminton. This paper takes 60 badminton players from some sports colleges in Nanchang City, Jiangxi Province and some badminton athletes in provincial sports schools as the research object. The FMS functional exercise test method combined with mathematical statistics method is used to explore the causes of sports injuries and establish a sports damage prediction model. Understand the damage characteristics of the badminton project, the multiple sites of injury, and screen the subjects for functional actions. The results of the experiment showed that the results of FMS scores were not related to the history of previous injury. In the absence of pain, the presence of injury history had no significant effect on the score of FMS, but physical asymmetry is significantly associated with FMS scores. The FMS score and the predicted incidence of injury for badminton players are 14 points. FMS functional screening can be used as a measurement tool to predict the occurrence of damage and can effectively predict the occurrence of damage.

Key words: Badminton, Cause of Sports Injury, Prediction Model, FMS

Causas de Lesiones Deportivas en Jugadores de Bádminton y Diseño de Modelos de Pronóstico

Resumen
El bádminton es un tipo de movimiento antialérgico con una alta incidencia de lesiones. La lesión deportiva trae grandes problemas a los participantes, afectando el entusiasmo de los participantes por los deportes y no es propicio para el desarrollo saludable del bádminton. Este artículo toma como objeto de investigación a 60 jugadores de bádminton de algunas universidades de deportes en la ciudad de Nanchang, provincia de Jiangxi y algunos atletas de bádminton en escuelas de deportes provinciales. El método de prueba de ejercicio funcional FMS combinado con el método de estadística matemática se utiliza para explorar las causas de las lesiones deportivas y establecer un modelo de predicción de daños deportivos. Comprenda las características de los daños del proyecto de bádminton, los múltiples sitios de lesión, y evalúe los sujetos para acciones funcionales. Los resultados del experimento mostraron que los resultados de las puntuaciones FMS no estaban relacionados con el historial de lesiones anteriores. En ausencia de dolor, el historial de lesiones no tuvo un efecto significativo en la puntuación de FMS, pero la asimetría física se asocia significativamente con las puntuaciones de FMS. La puntuación FMS y la incidencia prevista de lesiones para los jugadores de bádminton son 14 puntos. La detección funcional de FMS se puede usar como una herramienta de medición para predecir la ocurrencia de daños y puede predecir efectivamente la ocurrencia de daños.

Palabras clave: Bádminton, Causa de Lesión Deportiva, Modelo de Predicción, FMS.

1. Introduction

The badminton sport is a small ball sports project that fights against each other through the net. It is actually a skill-oriented type of net-facing sports. Badminton sports have strong confrontation, high exercise intensity, no time limit in competition, and strong resilience and sensitivity to athletes. Therefore, badminton sports are very demanding on athletes' strength, speed, endurance, sensitivity and coordination. They need high anaerobic exercise capacity and good aerobic exercise ability. In badminton, if the basic skills are not well-played, the movements are unscientific and irregular, and it is easy to cause sports injuries. When the athlete's body is in a state of fatigue, it may cause the technical movement to deform, or the attention may be slightly reduced, and the sports injury may also occur. These injuries not only affect the performance of
badminton players, but also bring injuries to athletes and become obstacles to the road to high-level athletes. The author believes that the study of the causes of common sports injuries of badminton players, early prevention and prediction, is of great significance to the development of badminton players.

Many people are studying about the sports injuries and prevention of badminton. Xu Jinxin et al. [1] investigated the badminton specialization and elective students of Shihezi University, and investigated the incidence, type, location and cause of injury in the two participating groups through questionnaire survey. There are large differences in the above aspects of the population, which provides a theoretical basis for the development of preventive measures for sports injuries in different badminton players. Liu Lu [2] used literature methods, mathematical statistics, interviews and other methods to analyze and study the characteristics of badminton, the special quality of badminton, the impact of badminton special training on physical fitness, badminton training and sports injuries and psychology. According to the research and analysis, during the training process, the prevention and protection awareness of the sputum, wrist, shoulder and other parts that are likely to cause sports injuries are strengthened; and the preparation activities are fully prepared. Lu Baoxiang et al. [3] summarized the causes of common sports injuries of amateur badminton players on the basis of previous studies, and made suggestions from wrong hitting actions. Yang Yan [4] based on the literature of China's badminton research from 1990 to 2017, based on the statistical analysis method, comprehensively understand and master the problems and shortcomings of badminton research in China, including the analysis of sports injuries of badminton players. Wang Liduan [5] carried out the left and right squatting movements of the eight badminton college students before and after fatigue, and compared the lower extremity kinematics data and the plantar pressure data before and after the fatigue step. The study found that after fatigue, the lower extremity landing in a more upright posture will increase the joint impact of the lower extremities, while increasing the load on the knee joint, especially the anterior cruciate ligament, increasing the risk of injury; the change in the pressure distribution of the plantar foot after fatigue may increase the risk of foot injury, especially in the medial temporal region of the forefoot and knee injury. Lu Lin [6] used the literature method, questionnaire survey method and interview method to investigate the current sports injury status of 368 students in Hunan University of Arts and Science. The risk of sports injuries caused by badminton, football and basketball was high. The distribution of the injury site is mainly caused by ankle, knee and wrist injuries. Lu Jihong [7] first analyzed the importance of footwork training in college badminton teaching process, mainly to stimulate students' interest, reduce sports injuries, and improve students' physical quality and athletic ability. Then, from the aspect of increasing the teaching theory of badminton footwork theory, the method of step training in college badminton teaching is proposed. Zhao Yingying [8] investigated the related factors of wrist and sleeve injury in badminton, and combined with the sports characteristics of badminton project, analyzed the causes, treatment methods and preventive measures of sports injuries. Dong Dandan et al. [9] found in the article "Causes and preventive measures for sports injuries in badminton events" that the probability of sports injuries caused by badminton players is quite high, mainly due to the technical movements of badminton enthusiasts and the excessive burden of local burdens. For the cause of injury, corresponding rehabilitation measures and recommendations have also been proposed. Liang Xiaolong et al. [10] explored and studied the causes and prevention of ankle injury in the badminton teaching and sports injury disciplines by consulting materials, interviews, and issuing questionnaires. The questionnaire showed the reasons for the ankle joint injury and concluded that the physical education students neglected the knowledge learning of the prevention of ankle injury due to the lack of attention to the ankle joint injury. The type of injury to the ankle joint in badminton is mainly the ankle ligament strain, contusion and fracture.

At this stage, most of the experts and scholars have suffered from the damage caused by badminton sports, such as the inappropriate sports skills and the incompatibility of sports venues. And in these studies, many methods for exploring the causes of sports injuries are unscientific. More importantly, the prediction method for badminton player injury is quite lacking, which is completely incompatible with the current status of popular badminton. Therefore, a scientific badminton player injury prediction method is urgently needed to reduce sports injuries.

This paper applies the Functional Movement Screen (FMS) method to the damage prediction of badminton players. FMS and functional action training originated from the American Athletic Performance Institute [11]. The purpose and function of the test are to test and evaluate the ability and movement structure of the human body to master and apply the basic body movements, and formulate and design corrective action exercises according to the test results, so as to effectively avoid sports injuries caused by wrong actions and improve the efficiency of exercise and the rationality of exercise. Functional action training consists of 8 core content, and "Functional Action Screening” is one of its core contents [12]. The FMS was developed in 1995 by USA-based rehabilitation expert Gray Cook and training specialist Lee Burton in conjunction with clinical laboratory research and personal experience based on functional movements [13]. The effect of the subject's completion of the action is evaluated by the functional action screening result, and the formation or continuous deterioration of the sports injury is minimized. The functional action screening test consists of seven basic test actions and three...
additional injury check action tests, which are scored and evaluated according to the completion of the screening actions of the subjects [14]. The MFS is a technique for evaluating functional function of the human body. It is expected to find the movement limitation and asymmetry of the subject's body through the completion of the screening action by the subject [15]. This evaluation technique can amplify the problem of the body compensating when the subject completes the movement, and we can find the problem where the body has problems. When the human body completes certain movements, the movement of the body will lead to the occurrence of weak chains of the sports system, and the athletes will not be able to complete the technical movements during the competition and training, and there is a corresponding risk of athletes' sports injuries. The FMS can be used as a test to examine the athlete's body to identify problems that exist on the body during exercise, that may occur, and that are difficult to detect during traditional medical examinations [16]. This kind of test based on the physical completion of the movement can detect functional movement limitation and body asymmetry related to proprioception, body balance and stability [17]. If you use functional action screening to find out these problems, you can change the athlete's physical exercise pattern early, thus reducing the athlete's sports injury, and thus improve the athlete's athletic performance.

The FMS method has been widely used in various fields and has achieved good results. Gao Xiaotong et al. [18] used the standard FMS test to collect data on the active national team and provincial football players in China, tracked and investigated the non-contact injuries of Chinese football players, and used relevant indicators to successfully assess the value of sports injury risks. Guo Yurui, Yuan Benfei [19] applied the FMS to the special training of martial arts routines, which improved the flexibility, flexibility, balance control ability and reduced sports injuries of martial arts routine practitioners. Zhang Rui et al. [20] applied the FMS method to the physical training of tennis special students, which effectively improved the basic motor function of tennis special students, improved the weak chain links in their movements, and reduced the incidence of sports injury. Lei Xiang et al. [21] applied the FMS method to the physical function training of basketball special students. The results showed that physical function training improved the physical weak chain of the body and improved the body function level. Fan Dongxiang [22] applied the FMS method to the motor function diagnosis of gymnastics team members, helping athletes to prolong their sports life and achieve excellent results. Wang Jingru et al. [23] conducted a comprehensive functional assessment of the physical activity test (FMS) of the Kayak athletes in Hebei Province, and found out the problems of the athletes. Combine with the actual training to carry out theoretical analysis, find the limiting factors of technical problems and propose solutions, and provide theoretical and practical basis for preventing and reducing sports injuries. Huang Cheng [24] applied the FMS method to the training of college table tennis players. It was found that FMS monitoring has a guiding effect on college table tennis players' training, and better stability and flexibility can improve the athletic performance of college table tennis players. Liu Tao et al. [25] based on the functional motion detection principle, studied and analyzed the physical functional motor function of naval academy students, and found that the naval academy students have poor physical functional exercise ability, high risk of sports injury, and scientific degree of military training is insufficient. The FMS method is widely used in the detection of various types of sports and has achieved good results, so it can be applied to the prediction of teleportation of badminton players.

In order to study the causes of sports injuries of badminton players, this paper uses FMS functional exercise test method, combined with logistic regression analysis, chi-square test and t-test method to establish a damage prediction model for badminton players. It is proved by experiments that the results of FMS scores are not related to the history of previous injury. In the case of the subjects without the pain, the occurrence of injury history has no significant effect on the score of FMS, but the physical asymmetry is significantly associated with FMS scores. The FMS score and the basketball player injury rate prediction segmentation point is 14 points. The occurrence of injury during the observation period is related to the FMS score, When FMS≤14, the injury rate of athletes is high. Functional motion screening can be used as a measurement tool to predict the occurrence of sports injuries, and can effectively predict the occurrence of sports injuries. However, asymmetry is not alone as a factor in the occurrence of damage. First, FMS score points should be established. In the case of low scores, asymmetry is an additional risk factor.

2. Method

2.1. Functional Movement Screen (FMS)

The Functional Movement Screen is a set of detection methods used to detect the athlete's overall motion control stability, body balance, softness, and proprioception. Through FMS detection, individual functional limitations and asymmetric development can be easily identified. This is used as a basis for detecting potential injuries and training for athletes, and to improve athletes' athletic ability and extend their sports life.

The FMS test detects the symmetry, weak chain and limitations of human motion through 7 basic actions, tracks the performance of sports compensation, and solves the weak chain and limitations of the body through
corresponding action training to reduce the sports injuries of athletes and improve the athletic ability of athletes. The FMS test bridges the gap between sports medicine and physical training, allowing trainers to use rehabilitation knowledge more consciously to serve athletes’ health during physical training.

As shown in Figure 1, the FMS consists of seven simple motion tests: Deep Squat, Hurdle Step, In-line Lunge, Shoulder Mobility, Active Straight Leg Raise, Trunk Stability Push-Up, Rotary Stability, and three troubleshooting tests (Pain in the shoulder joint, pain in flexion of the spine, pain in the extension of the spine). Through these 7 basic actions, the tester can quickly and clearly observe the basic motion, control, and stability of the testee's actions.

The FMS scoring criteria are divided into the following four categories. 0 points: Pain occurs in any part of the testee's actions. 1 point: The testee cannot complete the entire action or cannot return to the starting position. 2 points: The action performed by the testee is incomplete. 3 points: The testee can complete the measured action with a high standard.

![Figure 1. FMS action test](image)

2.2. Binary logistic regression model

For the two-class dependent variable, if we use multiple linear regression analysis, we get the linear probability model (LPM), but the linear regression method usually requires the dependent variable to be the distance measurement scale. Moreover, the error terms of different independent variables corresponding to the dependent variables must have the same variance, that is, the homogeneity of the variance. If the least squares method (LSM) is used to estimate the LPM model, these assumptions are violated, and the results no longer have the characteristics of the best linear unbiased estimation. The requirements of the Logistic model are not as strict as the LSM model: 1) there is no need to assume a linear relationship between the independent variable and the dependent variable; 2) the normality of the distribution of variables (especially the dependent variable) is not required; 3) the homogeneity of variance is not required. Therefore, we use the binary logistic regression method to build the model, and use the maximum likelihood estimation method to estimate the parameters.

Logistic model: The conditional probability of occurrence of an event is recorded as \( P(y_i=1|x_i) \), where

\[
p_i = \frac{1}{1 + e^{-(\alpha + \beta x_i)}}
\]

represents the probability of occurrence of the i-th event, then the probability of non-occurrence is

\[
1 - p_i = \frac{1}{1 + e^{-(\alpha + \beta x_i)}}
\]

Then the ratio of the probability of occurrence to the probability of non-occurrence is

\[
\frac{p_i}{1 - p_i} = e^{\alpha + \beta x_i}
\]

This ratio is called odds and is called the occurrence ratio of events. Take odds as the natural logarithm to get:

\[
\log \text{it}(p_i) = \ln \frac{p_i}{1 - p_i} = \alpha + \beta x_i
\]

It is called logit transformation, so the relationship between \( \log \text{it}(p_i) \) and argument \( x \) is linear after transformation.

When there are \( k \) arguments, the formula expands to
\[ \log \text{it}(p_i) = \ln \left( \frac{p_i}{1 - p_i} \right) = \alpha + \sum_{k=1}^{k} \beta_k x_{ik} \]

The correspondence can be used to find the probability:

\[ p_i = \frac{\exp(\alpha + \sum_{k=1}^{k} \beta_k x_{ik})}{1 + \exp(\alpha + \sum_{k=1}^{k} \beta_k x_{ik})} \]

For the above model, we use the maximum likelihood estimation method to estimate its regression parameters. Maximum likelihood estimation is a method of estimating parameters using the overall distribution function or probability density function and the information provided by the sample. Unlike previous least squares estimation, the least squares estimation is to minimize the sum of squared residuals of sample observation data.

Maximum Likelihood Estimation Method: Suppose there are n observation samples with observations of y1, y2, and y3. Let \( p_y = p(y_i = 1 | x_i) \) be the probability of getting \( y_i = 1 \) under given conditions. The conditional probability of obtaining \( y_i = 1 \) under the same conditions is \( 1 - p_y \). Thus, the probability of getting an observation is \( p(y_i) = p_y^y (1 - p_y)^{1-y_i} \), \( y_i = 1 \ or \ 0 \). Because the observations are independent, their joint distribution can be expressed as the product of the marginal distributions.

\[ L(\beta) = \prod_{i=1}^{n} p_i^y (1 - p_i)^{1-y_i}, \text{in which } p_i = \frac{\exp(\alpha + \sum_{k=1}^{k} \beta_k x_{ik})}{1 + \exp(\alpha + \sum_{k=1}^{k} \beta_k x_{ik})} \]

The above formula is called the likelihood function of n observations. Our goal is to be able to find a parameter estimate that maximizes the value of this likelihood function. Therefore, the key to the maximum likelihood estimation is to find the parameters and make the above formula obtain the maximum value. Find the logarithm of the above function:

\[ \ln L(\alpha, \beta) = \sum_{i=1}^{n} \left[ y_i \ln p_i + (1 - y_i) \ln(1 - p_i) \right] \]

\[ = \sum_{i=1}^{n} \left[ y_i \ln \frac{p_i}{1 - p_i} + \ln(1 - p_i) \right] \]

\[ = \sum_{i=1}^{n} \left[ y_i (\alpha + \sum_{k=1}^{k} \beta_k x_{ik}) - \ln(1 + \exp(\alpha + \sum_{k=1}^{k} \beta_k x_{ik})) \right] \]

The above formula is called a log likelihood function. In order to estimate the maximum value of the log-likelihood function, the function is derived to obtain \( k+1 \) likelihood equations.

\[ \frac{\partial \ln L(\alpha, \beta)}{\partial \alpha} = \sum_{i=1}^{n} \left[ y_i - \frac{\exp(\alpha + \sum_{k=1}^{k} \beta_k x_{ik})}{1 + \exp(\alpha + \sum_{k=1}^{k} \beta_k x_{ik})} \right] \]

\[ \frac{\partial \ln L(\alpha, \beta)}{\partial \beta_k} = \sum_{i=1}^{n} \left[ y_i \frac{\exp(\alpha + \sum_{k=1}^{k} \beta_k x_{ik})}{1 + \exp(\alpha + \sum_{k=1}^{k} \beta_k x_{ik})} \right] x_{ik} \]

Let the above partial derivative equation be 0, and solve the problem in parallel, and the parameter solution can be obtained, so that the likelihood function reaches the maximum value. Solve the above nonlinear equation and apply the Newton-Raphson method for iterative solution.

Through binary logistic regression, the contribution of FMS test scores to damage risk prediction is analyzed, and the key models for predicting damage risk are identified.
2.3. Statistical methods

1. Chi-square test

The chi-square test is the degree of deviation between the actual observation value and the theoretical inference value of the statistical sample. The degree of deviation between the actual observation value and the theoretical inference value determines the magnitude of the chi-square value. If the chi-square value is larger, the degree of deviation between the two is smaller; on the contrary, the greater the deviation between the two, if the two values are completely equal, the chi-square value is 0, indicating that the theoretical value is completely consistent.

The steps of the chi-square test are as follows:
(1) Propose the null hypothesis:
$H_0$: The distribution function of the population $X$ is $F(x)$.
If the overall distribution is discrete, then specifically
$H_0$: The distribution law of the total $X$ is $P\{X = x_i\} = p_i, i = 1, 2, \cdots$
(2) The value range of the overall $X$ is divided into $k$ mutually disjoint inter-cells $A_1$, $A_2$, $A_3$, ... $A_k$, which can be taken as $A_1 = (a_0, a_1], A_2 = (a_1, a_2], ..., A_k = (a_k - 1, a_k)$
(3) The number of sample values of $A_i$ falling into the $i$-th cells is denoted $f_i$, and becomes the group frequency (true value), and the sum of all group frequencies $f_1 + f_2 + \cdots + f_k$ is equal to the sample size $n$.
(4) When $H_0$ is true, based on the assumed overall theoretical distribution, the probability $p_i$ of the value of the population $X$ falling within the $i$-th cell $A_i$ can be calculated. Thus, $np_i$ is the theoretical frequency (theoretical value) of the sample values falling within the $i$-th inter-cell $A_i$.
(5) When $H_0$ is true, the frequency $f_i/n$ of the sample value falling into the $i$-th cell in the $n$ trials should be very close to the probability $p_i$. When $H_0$ is not true, $f_i/n$ and $p_i$ are very different. Based on this idea, Pearson introduced the following test statistic.

$$
\chi^2 = \sum_{i=1}^{k} \frac{(f_i - np_i)^2}{np_i}
$$

In the case where the hypothesis of 0 is established, the chi-square distribution with a degree of freedom of $k-1$ is obeyed.

2. t-test

The t-test, also known as the Student's t test, is primarily applicable to normal distributions where the sample content is small (eg, $n < 25$) and the population standard deviation $\sigma$ is unknown. The t-test uses the t-distribution theory to infer the probability of occurrence of the difference, thereby comparing whether the difference between the two means is significant. It is juxtaposed with the f-test and the chi-square test. The t-test was invented by Gosset to observe the quality of the wine and was published on Biometrika in 1908. The t test can be divided into a single overall test and a double overall test, as well as a paired sample test.

(1) Single population test

The single population t-test is to test whether the difference between a sample mean and a known population mean is significant. When the population distribution is a normal distribution, if the population standard deviation is unknown and the sample size is less than 25, then the dispersion statistic of the sample mean and the population mean is t-distributed. The single population t-test statistic is:

$$
t = \frac{\bar{x} - \mu}{\sigma x / \sqrt{n - 1}}
$$

Where $i = 1, \cdots, n, \bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$ is the sample mean, $s = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n - 1}}$ is the sample standard deviation, and $n$ is the number of samples. The statistic $t$ obeys the t-distribution with a degree of freedom of $n-1$ under the condition of zero hypothesis: $\mu = \mu_0$ is true.

(2) Double population test

The double population t-test is used to test whether the difference between the average of the two samples and the population they represent is significant. The double population t-test is divided into two cases. One is the independent sample t-test (there is no correlation between the experimental treatment groups, that is, independent samples), which is used to test the difference in the data obtained by two groups of non-related samples; the second is the paired sample t test, which is used to test the difference between the data obtained by...
the two groups of participants or the data obtained by the same group of subjects under different conditions. The sample consisting of these two cases is the relevant sample. The independent sample t-test statistic is:

\[
t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}}} \left(\frac{1}{n_1} + \frac{1}{n_2}\right)
\]

\(S_1^2\) and \(S_2^2\) are two-sample variance; \(n_1\) and \(n_2\) are two-sample capacity.

(3) Paired sample test

The paired sample t-test can be viewed as being extended on the basis of a one-sample t-test, but the test object is the difference between a group of observations from a normal assignment independent sample to a two-group paired sample. If the difference between the two paired samples \(X_{1i}\) and \(X_{2i}\) is \(d_i = X_{1i} - X_{2i}\) independent and comes from the normal assignment, then the maternal expected value \(\mu\) of \(d_i\) is \(\mu_0\). The following statistics can be used:

\[
t = \frac{\overline{d} - \mu_0}{S_d / \sqrt{n}}
\]

Where \(i = 1, \ldots, n, \overline{d} = \frac{\sum_{i=1}^{n} d_i}{n}\) is the average of the paired sample differences, \(S_d = \sqrt{\frac{\sum_{i=1}^{n} (d_i - \overline{d})^2}{n-1}}\) is the standard deviation of the paired sample difference, and \(n\) is the number of paired samples. The statistic t obeys the t-distribution with a degree of freedom of \(n-1\) under the condition of zero hypothesis: \(\mu = \mu_0\) is true.

3. Experiment

3.1. Experimental object

A total of 60 badminton athletes from some sports colleges in Nanchang City, Jiangxi Province, and some provincial sports badminton athletes were used as experimental subjects. Among the subjects, 30 were males and 30 were females. The badminton time of the subjects ranged from 4 to 15 years; the study selected athletes aged 12-22 years to conduct experiments; the subject's physical health was good and there were no restrictions on normal exercise caused by surgery or severe trunk injuries within the last six months. The experimental observation period is from April 9, 2018 to May 3, 2018.

3.2. Laboratory equipment

FMS test kit, tape measure, 2 stopwatches, weight tester, yoga mat, foam shaft, elastic band, kettlebell, badminton.

3.3. Data Statistics and Processing

Statistical analysis was performed on all data to analyze whether pre-injury and asymmetry affected FMS scores and to perform significant analysis using spss21.0 software. Establish an FMS segmentation point to analyze whether the occurrence of new lesions is related to FMS scores, asymmetry or not. Using t-test and chi-square test, it is verified whether functional limitation and asymmetry can effectively predict the occurrence of sports injuries. \(P < 0.05\) indicates statistical significance.

4. Results

Result 1: The relationship between FMS score and history of injury

According to the FMS results, the results of the FMS test score and the pre-existing injury of the subject are shown in Table 1.

<table>
<thead>
<tr>
<th>Table 1. MFS scores and pre-injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-injury</td>
</tr>
<tr>
<td>YES</td>
</tr>
<tr>
<td>NO</td>
</tr>
</tbody>
</table>

By significance test, \(P = 0.138\) was obtained, and its value was greater than 0.05. The results showed that there was no significant difference between the MFS score and the previous injury.
By retrospectively investigating the pre-experimental injury status of the subject, the proportion of the injured part of the subject is shown in Figure 2.

As can be seen from the above figure, the injured parts of the badminton players participating in the experiment are mostly wrist joints, accounting for 39.62%, followed by injuries such as shoulders and ankle joints. There was no significant difference between the athletes in the early stage and the FMS scores (P=0.138>0.05). All subjects were in the absence of pain when performing experimental measurements, indicating that the FMS test results can be compared between any individual without physical conditions associated with pain.

![Figure 2. The proportion of injured parts](image)

Result 2: Relationship between FMS score and body symmetry

According to the FMS results, the situation of body symmetry is shown in Table 2.

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>average score</th>
<th>95% confidence interval</th>
<th>Proportion (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The body is</td>
<td>21</td>
<td>17.18±1.17</td>
<td>15.89±17.62</td>
<td>35%</td>
</tr>
<tr>
<td>symmetrical</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The body is not</td>
<td>39</td>
<td>13.02±3.36</td>
<td>12.31±13.79</td>
<td>65%</td>
</tr>
<tr>
<td>symmetrical</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The results showed that the FMS scores of the symmetric and asymmetrical subjects were significantly different (P=0.038<0.05), and the FMS score was low when the body had one or more asymmetry. Symmetrical movements include squat and torso stability, and the other five test actions are asymmetrical movements, including stalking, bifurcation, shoulder flexibility, lower limb flexibility, and body rotation. These five asymmetry actions are tested separately on both sides, so only the scores on the side with the lowest score on both sides of the test are obtained when the score is obtained. When the subject's body has an asymmetry, the body's ability to move in a certain body link will decline, and high-standard technical actions will not be made. In the action function screening, the FMS score will be low.

Result 3: Establish FMS score and predicted break point of badminton player injury rate

Whether FMS can be used as a measurement tool to predict the occurrence of badminton injury, we must first establish a FMS score and damage incidence prediction segmentation point. According to the literature reviewed, this paper combines the action function screening results to separate the two segmentation points, and uses the chi-square test to calculate the relative risk of the OR value. (1) Considering the FMS score of 14 as the segmentation point, the occurrence and score of the new injury are shown in Table 3.

<table>
<thead>
<tr>
<th>FMS score</th>
<th>Get injured</th>
<th>Healthy</th>
<th>total</th>
<th>Injured rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMS≤14</td>
<td>4</td>
<td>8</td>
<td>12</td>
<td>33.33%</td>
</tr>
<tr>
<td>FMS&gt;14</td>
<td>6</td>
<td>42</td>
<td>48</td>
<td>12.5%</td>
</tr>
<tr>
<td>total</td>
<td>10</td>
<td>50</td>
<td>60</td>
<td>16.67%</td>
</tr>
</tbody>
</table>
The segmentation point for FMS was the chi-square test at 14 points, and the chi-square value was 5.208, P=0.025<0.05. Therefore, the difference in the incidence of injury between the two groups was considered statistically significant. The relative risk value of OR is 4.301. The lower limit of the 95% confidence interval is 1.149 and the upper limit is 15.796.

(2) Considering the FMS score of 16 points as the segmentation point, the occurrence and score of the new injury are shown in Table 4.

The FMS segmentation point is the chi-square test result of 16 points, the chi-square value is 4.936, P=0.027<0.05, so the difference in the incidence of injury between the two groups is considered statistically significant. The relative risk value of OR is 5.386. The lower limit of the 95% confidence interval is 1.062 and the upper limit is 25.774.

**Table 4:** The occurrence of new damage and the score of the FMS segmentation point is 16 points.

<table>
<thead>
<tr>
<th>FMS score</th>
<th>Get injured</th>
<th>Healthy</th>
<th>total</th>
<th>Injured rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMS≤16</td>
<td>9</td>
<td>24</td>
<td>33</td>
<td>27.27%</td>
</tr>
<tr>
<td>FMS&gt;16</td>
<td>2</td>
<td>25</td>
<td>27</td>
<td>7.41%</td>
</tr>
<tr>
<td>total</td>
<td>11</td>
<td>49</td>
<td>60</td>
<td>18.33%</td>
</tr>
</tbody>
</table>

Comparing the two sets of data, the damage rate is higher when FMS≤14 than FMS≤16, the larger the chi-square value is, the smaller the P value is, the more significant the result is, and the OR risk of FMS≤14 is not as large as FMS≤16, the confidence interval range is small. From the comparison of the two results, the FMS segmentation point is more meaningful when it is 14 points, so the FMS score and the badminton athletes participating in the experiment are predicted to be 14 points.

Result 4: Prediction of badminton injury by action limitation and asymmetric performance
(1) Establish a segmentation point with an FMS score of 14 to verify whether the FMS can be used as a measurement tool to predict the occurrence of damage. The FMS scores and the occurrence of new injuries during the observation period of the badminton players after training and competition are shown in Table 5.

**Table 5.** Relationship between FMS score and new injury occurrence

<table>
<thead>
<tr>
<th>FMS score</th>
<th>n</th>
<th>Get injured</th>
<th>Healthy</th>
<th>Chi-square value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMS≤14</td>
<td>12</td>
<td>4</td>
<td>8</td>
<td>5.196</td>
<td>0.023</td>
</tr>
<tr>
<td>FMS&gt;14</td>
<td>48</td>
<td>5</td>
<td>43</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As can be seen from the results in Table 5, in the subject, FMS ≤ 14, the incidence of injury was 33.33%, FMS was >14, and the incidence of injury was 10.42%. The FMS score ≤14 points increased by 22.91% compared with the FMS score >14, which is a relatively high incidence of injury. This also indicates that FMS functional screening can be used as a measurement tool to predict the occurrence of injury and can effectively predict the damage.

(2) To explore the effects of physical asymmetry on injury, the relationship between statistical asymmetry and the appearance of new lesions during the observation period is shown in Table 6.

**Table 6.** Asymmetric performance and statistics on the occurrence of new injuries during the observation period

<table>
<thead>
<tr>
<th>Symmetry</th>
<th>Get injured</th>
<th>Healthy</th>
<th>total</th>
<th>Injured rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>2</td>
<td>10</td>
<td>12</td>
<td>16.67%</td>
</tr>
<tr>
<td>NO</td>
<td>8</td>
<td>40</td>
<td>48</td>
<td>16.67%</td>
</tr>
<tr>
<td>total</td>
<td>10</td>
<td>50</td>
<td>60</td>
<td>16.67%</td>
</tr>
</tbody>
</table>

By chi-square test, the chi-square value was 0.041, and the significance test was P=0.552>0.05. Therefore, the difference in the incidence of injury between the two groups was not statistically significant. It is concluded that the asymmetry of the body is not a predictor of the risk of injury. The athletes in badminton are in the usual side. The long-term repetitive movements and postures of the athletes lead to the asymmetry of the muscles of the athletes’ ipsilateral and opposite sides. It is impossible to achieve absolute balance on both sides of the body but to be controlled within a certain range.

5. Discussion

Before the subjects conducted the experimental measurement, through a one-on-one questionnaire, it was found that there were 53 people with an injury experience within one year, accounting for 88.33% of the total
number of subjects. All subjects were in a state of no pain when performing experimental measurements. From the injury site analysis, the lesions that occurred in the subjects were mostly wrists, shoulders and ankle joints. It may be that the action concept of the athlete is vague, not standardized, the action violates the characteristics of the human body structure, and the action is stiff, and the sports damage is caused by the brute force. Many badminton strokes, such as high ball, ball killing, and ball shooting, require strong rotation of the elbow joints of the participants, and the angle is relatively large. If there is no training or improper training, the accumulation of time may gradually lead to damage. Such as high ball, lob, ball, ball, smash and other techniques, if you do not master the essentials, it will cause damage to the wrist joint, the external humerus, shoulder joints, etc.; badminton footwork is not familiar, body coordination Poor sex, support foot landing instability and cause a series of injuries such as knee joint, ankle or leg ligament strain.

The FMS test consists of seven basic functional test actions and three additional injury test actions, which are scored and evaluated based on the completion of the screening action. There are 5 asymmetric movements to test the left and right sides. When the scores on both sides are not the same, it is judged that the body asymmetry occurs, and the test result takes a smaller value. The exercise program is changed by the asymmetry of the body, which has a great influence on the completion of the movement. In the case of deviation of the movement, the FMS score is reduced. Therefore, the body symmetry is an influencing factor of the FMS score result.

FMS is a reliable and effective field testing tool, with lower individual scores increasing the risk of injury. Based on the experience of existing research, this paper establishes the segmentation point of FMS score and injury incidence prediction by badminton athletes, and sets the segmentation point to 14 points. For athletes with an FMS score of less than 14 points, it is generally recommended that special training should not be continued. Instead, rehabilitation training to enhance motor function should be put in the first place, which can alleviate the pain and reduce the chance of injury. The results of this study show that the damage rate is higher when FMS ≤ 14 minutes than FMS ≤ 16, the smaller the chi-square value is, the smaller the P value is, the more significant the result is, and the OR risk of FMS ≤ 14 is not as large as FMS ≤ 16. The range of the interval is small.

In this study, the asymmetry of the body is not a predictor of the risk of injury. In the relevant research, it is pointed out that the muscle itself has an asymmetrical tendency, which is related to the role of muscle in the function of movement. Ball sports are basically sports that exist on the side of the body. When athletes participate in sports for a long time, the normal and opposite muscles of the body are in an asymmetrical state.

6. Conclusion

The study of badminton is a process, obeying the principle of gradual and orderly, step by step to learn to master, and must not be too hasty. Before each exercise, you must do a good preparation to mobilize your physical skills to make your body warm up, which in turn can improve muscle stretch, joint flexibility and movement coordination. Learn more about sports injuries and strengthen your sense of self-protection. It is also possible to protect vulnerable parts in advance to avoid damage. Therefore, this article combines the causes of sports injuries and uses FMS to establish a damage prediction model, hoping to help those who have been or will be engaged in badminton. It is hoped that athletes will reduce their chances of injury and improve their health in badminton while improving their level of exercise.

Acknowledgements

This work was supported by Topnotch Academic Programs Project of Jiangsu Higher Education Institutions, PPZY2015 A007

References

and Science”, *Contemporary Sports Science and Technology*, 8(13).


