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## The research on the sports biomechanics analysis of the basic movement in dance

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### ABSTRACT

Sports biomechanics has become an important branch of biomechanics, which is mainly applied by mechanics principle and approach in order to research the structure and function of biological systems. Sports dance is through the body dynamics, the change of amplitude, velocity and attitude model, show the body beauty and natural beauty of the movement. In the current paper, the sports biomechanics analysis of the basic movement in dance has been researched in detail. By means of test approach, six ballet students are chosen as the object to test their basic motion of dancing. This paper presents the biomechanics theory advance in dance. The objective of this research can deal with the detailed mechanical analysis of sports dance process for dancer and coach to avoid the happening of the injury or accident. According to the force of research, the height and speed of jumping for every tested person are recorded and mainly discuss the influence of the center of gravity and speed. The analysis results indicate that the two factors are of utmost significance in practical training.

### KEYWORDS

Sports dance; Biomechanics; Center of gravity; Jumping speed.



## INTRODUCTION

During the few decades, sports dance has gradually become more popular events for general public, which is usually used for keeping-fit exercise, entertainment and recreation. With the continuous development of sports dance in our country, sports or competitions have demanded practitioners to have higher and higher sports dance professional theoretical knowledge and their action technology, so all hope that it is able to use the knowledge in the field of sports science technology of sports dance movement features in-depth study. However, at the same time, in many of the sports injury during training process also affects the athletes, which require their competitive level to be further improved<sup>[1,2]</sup>.

In general, sports biomechanics has become an important branch of biomechanics, which is mainly applied by mechanical principle and approach in order to research the structure and function of biological systems. So far, it has been also an important research subject of sports science and plays a vital role in the development of our country sports enterprise, especially technical analysis of all the sports, sports training, design and improvement of the sports equipment, and sports injury prevention<sup>[3]</sup>. In a study by Luke and his colleagues, a profile was developed as to the demographics and background of a typical modern dancer. They found that modern dancers are a unique group of artists, performing a diverse repertoire in dance companies of various sizes. Therefore, in order to have better development of sports dance in our country, scholars should further explore the movement law of sports dance, using relevant knowledge of science and technology of sports dance sports biomechanics research, to better guide the teaching and training work<sup>[4]</sup>. As long as strengthening science and technology research, our country sports dance level will get a higher ascension, paying attention to the combination of theory and teaching practice.

Sports dance about the action of static or dynamic can be almost all studied by the mechanical knowledge of statics and dynamics. Phenomenon of Newton's three laws of mechanics can be utilized to deal with every movement of the sports dance performed by the players at any time<sup>[5,6]</sup>. During teaching process, the detailed analysis of the mechanics principle to students can make students better understand teachers' intentions so that it can improve dance level rapidly. In the current paper, test of dancing biomechanics is carried out. By means of biomechanics theory in dance, the research on the sports biomechanics analysis of the basic movement in dance can be settled. The objective of this research can deal with the detailed mechanical analysis of sports dance process for dancer and coach to avoid the happening of the injury or accident. According to the force of research, the height and speed of jumping for every tested person are recorded and mainly discuss the influence of the center of gravity and speed. The analysis results indicate that the two factors are of utmost significance in practical training.

## TEST OF DANCING BIOMECHANICS

### Test method

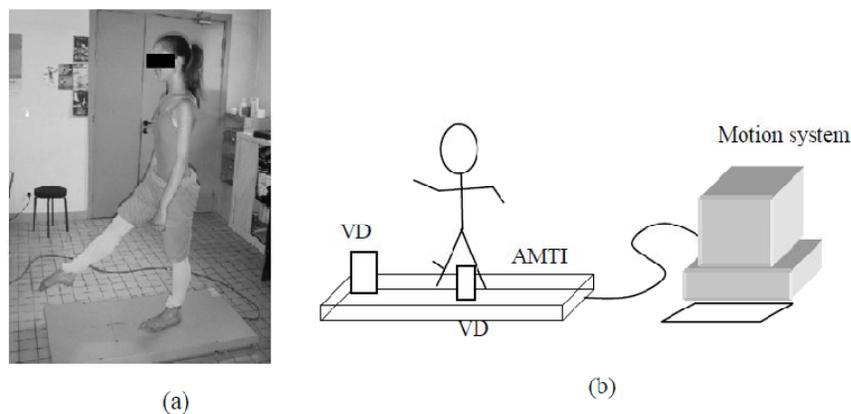
Experimental methods are mainly composed of kinematics and dynamics research methods, and biological research is complementary. In the present paper, the integrated use of a variety of experimental methods is employed to research the sports biomechanics analysis of the basic movement in dance. 3D video and computer analysis system for human body such as kinematics parameters in the process of complete the dance movements are utilized to analyze the movement process. Three dimensional (3D) electronic measurement approaches is used to obtain kinetic parameters such as load, which is more scientific and practical. This approach has been widely used in all aspects. It can use muscle all records in the process of the dance movements of some key muscles work. At the same time, this study adopts the multi-motor synchronous test, which can collect test data by instrument equipment such as video cameras and record load during dance movement process. The corresponding test and data collection can be used to analyze the influential principle. It can guarantee comparability and comprehensive of collective test data to accurately record the test process and the kinematics parameters.

Six students major in the ballet dancing are chosen as the research object of this experiment. There are two reasons to choose them. On one hand, they have better body qualities. On the other hand, they own better dance basis due to the professional training of ten years more. It can ensure the accuracy and effectiveness. Their basic information such as gender, age, height, weight and the year of learning dance is listed in the TABLE 1.

**TABLE 1: The basis information of studied dancers**

Test number	Age	Height (cm)	Weight(kg)	Learning Years
Man-1	20	178	61.5	12
Man-2	18	180	63	12
Man-3	23	175	60	15
Woman-1	19	168	43	14
Woman-2	20	170	46	12
Woman-3	22	172	45	16

In this experiment, test equipments mainly contain two digital video cameras, motion analysis systems and AMTI load stage. The video cameras are used to record the motion process of tested students. Then it can employ the motion analysis system to settle the dancing motion process, for example, the change of the center of gravity. Similarly, AMTI load stage can be utilized to compute the force and speed of the leaping ability (Figure 1). During the test process, every tested dancer was required to respectively complete the genuflexion motion with different extend, such as shallow squat, normal squat and grand squat. Finally, tested person jumps and the height and speed of jumping are recorded. The test results are shown in TABLE 2.

**Figure 1: Detailed test set-up****TABLE 2: Test index results**

Test	Height (cm)	Speed (m/s)	Force (N)	
Man	M-1	48.2	3.43	1084
	M-2	51.6	4.46	1135
	M-3	42.4	3.05	1022
	Average	47.4	3.646	1080.3
Woman	W-1	32.7	2.36	623
	W-2	30.4	2.11	586
	W-3	33.8	2.52	687
	Average	32.3	2.33	632

### Analysis and discussion of test results

Test method is an effective and accurate tool to realize the task of a research project. According to the test object, testing property is divided into kinematics parameters measurement, dynamic measurement and the biology parameter measurement, etc. Kinematics parameter measurement refers to measure the movement characteristics of time and space feature parameters, such as velocity,

acceleration, track, etc. On the other hand, Kinetic parameters measurement refers to the force and torque, moment of inertia parameter measurement. Meanwhile, biological parameters measurement refers to biological factors, such as muscle, muscle power measurement. In the present paper, the velocity of jumping, height and loading to the testing instrument are reasonably recorded. Then, the information is utilized to analyze the effect of dancing biomechanics.

Among the sports dance, the center of gravity of dancing person is of utmost importance because it is related to the beauty of dancing posture. On the other hand, the jumping speed determines the safety of sports dancer. During the test process, the change of center of gravity and jumping speed were recorded. From seen the Figure 2 and 3, it can be found that the trend of change for six tested persons is generally same. With respect to the change of center of gravity, to a large extent, it is dependant to the body height and weight of a person. One can say that in general, the height of male is higher than the female. Therefore, the ratio of gravity height for tested men is slightly larger than women. Figure 3 indicates the change of speed with different tested persons. The leaping speed direction is different due to jumping up and down. It is mainly dependant to the jumping height. From TABLE 2, it is found that the jumping height values of men are obviously larger than women, about 1.5 times. Therefore, the center of gravity and speed can not be ignored during dancing training, or it will lead to several unnecessary injuries.

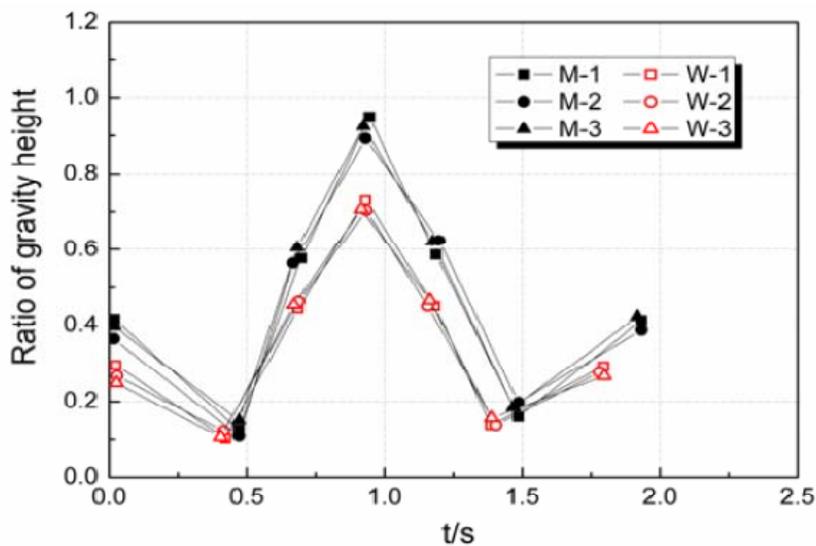


Figure 2: The change curve of center of gravity

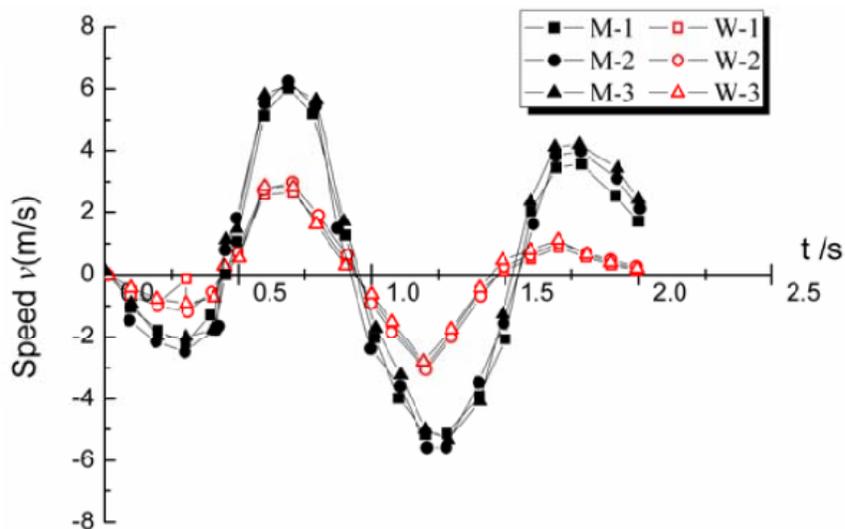


Figure 3: The change curve of speed

### **Biomechanics theory advance in dance**

Since the middle of 20th century, the application of biomechanics is combined with sports science theory to study human movement conditions mature, which gradually formed as an independent discipline. Along with rapid development of the computer, high-speed photography, sensors, the application of the analytical system and electronic technology, it can make the accurate measurement and analysis of human movement parameters to become a reality. The development of modern science and technology for sports biomechanics research has laid a solid material foundation. The development trend of modern sports biomechanics research methods in the study of technology for sports, which presents a more scientific and practical experimental research to analyze the basic characteristics of sports dance.

Sports biomechanics is comprehensive mechanics combined with biology and human movement science cross discipline. In recent years, the research of sports biomechanics has widely used in many projects, to have a better understanding about the rule of sports technology and enhancing the technical levels of movement, which play an important role. Sports dance is through the body dynamics, the change of amplitude, velocity and attitude model, show the body beauty and natural beauty of the movement, but also as a natural and unrestrained neat action, graceful and dynamic music show modern Latin dance artistic style or ballet dancing. Because of its unique artistic features, so that people were mainly focused on its artistic expression, and neglect the mechanical nature of the movement. This study uses the theory and method of sports biomechanics study of sports dance in the human body mechanics problem, in order to sports dance movement rule has more profound and comprehensive understanding, this will be to improve the sports dance movement technology, raise the scientific nature and effectiveness of sports dance teaching training has a positive role.

Using the principle of transfer kinetics of sports biomechanics and anatomy knowledge analysis of sports dance spins, the analysis of the rotation angle and the support force can make sports dance in the spinning finish more fluent and appropriate to reduce the risk of loss. The artistic body movements displayed in dance place specific demands on the body in terms of endurance and aerobic capacity, muscle strength, overall flexibility, joint stability, somatosensory integration and neuromuscular coordination. Departments of Health in the UK and US acknowledge that only a few sufferers receive treatment. For example, the USA Department of Health and Human Services reports that only one in five adult sufferers receive adequate treatment in accordance to guide-lines set by the American Psychiatric Association; even fewer receive treatment amongst ethnic minority groups<sup>[7]</sup>. Sports dance movement technical level is becoming more rich artistic appreciation value direction, so a lot of sports dance players will inevitably occur in the practice game sports injury, with the theory of mechanics of research method and the experimental research method of sports biomechanics research, to minimize the risk of sports injury. Using advanced testing instrument, observing and analyzing the characteristics of the athlete movement in the process of movement, we found that the motion characteristics and the relationship between the damage. According to the biomechanics principles of dance, movements design is more suitable for sports dance sports equipment and can reduce the maximum of the metatarsal injuries dance shoes, which will provide a scientific basis for prevention of sports dance movement damage. The continuous deepening of the research of the scathe of sports dance, foot biomechanics research will play an important role in the study of dance sport injury. Therefore, sports biomechanics methods mean to improve sports level and promote innovation so that prevention and treatment of sports injuries play an important role.

### **CONCLUSIONS**

In this present paper, the sports biomechanics analysis of the basic movement in dance has been researched in detail. By means of test approach, six ballet students are chosen as the object to test their basic motion of dancing. This paper presents the biomechanics theory advance in dance. According to the force of research, the height and speed of jumping for every tested person are recorded and mainly discuss the influence of the center of gravity and speed. The analysis results indicate that the two factors

are of utmost significance in practical training. The main conclusions in this paper can be briefly summarized as the following:

(1) Among the sports dance, the center of gravity of dancing person is of utmost importance because it is related to the beauty of dancing posture. The change of center of gravity, to a large extent, it is dependant to the body height and weight of a person.

(2) It is found that the jumping height values of men are obviously larger than women, about 1.5 times. On the other hand, the jumping speed determines the safety of sports dancer.

(3) The application and advance of biomechanics theory is presented in details. The study on sports biomechanics methods not only can improve sports level for the sports players but also decrease the happening of the accidents science. Consequently, the application and advance of biomechanics theory play a significant role in sports dancing.

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