

# Research on the impact of congenital joint activity and flexibility on the development of dancers

**Xinyue Hu**

Beijing Dance Academy, The Affiliated Secondary School of Beijing Dance Academy, Beijing, 100081, China

yxy2009@tzc.edu.cn

**Abstract.** The importance of range of motion and flexibility in dance training is self-evident. The article aims to solve the typical training problem of dancers due to the growth difference between joints and muscles under various conditions. Common hip injuries in dance training include iliopsoas muscle strain, synovitis, etc., which may be caused by sudden twisting or overextension of the hip joint. To improve flexibility, auxiliary training such as Pilates has become the first choice for dancers, by strengthening the toughness and stretching of fascia and muscles, reducing the risk of hip friction and injury. In auxiliary training, the training of antagonist muscles is crucial, by transposing a set of antagonist muscles to exert force, effectively improving leg flexibility while maintaining joint stability. In addition, the activation of the physical function of the trainees before the class is also key, and the warm-up activities are used to increase the level of bursts and reduce the risk of muscle strain. Taking into account the range of motion, flexibility training, and physical function activation, we can provide dancers with a more scientific and effective dance training program to ensure their physical health and performance quality.

**Keywords:** Congenital joint activity, flexibility, injury, dance.

## 1. Introduction

In today's era, with the comprehensive growth of dance culture, the increasing attention it receives highlights its significance as an irreplaceable art form. As a carrier of art expression, the dancer will express and transmit emotions with the body. So, the dancer will pass a long period of self-tempering to achieve the level and quality of the art profession. Dancers were asked to enter professional colleges and institutions to start polishing themselves because of such a professional nature. Starting from various conditions, coaches will conduct comprehensive training and development of them. In the art of dance, it values the physical conditions of the students, including height ratio, muscle strength, and physical flexibility. After the investigation and research of Beijing Dance Academy, the author found that most of the requirements are congenital. Although it does not mean that it cannot be achieved by acquired training, it is very difficult. Among these items, the most important thing is the flexibility of the dancer. This is because in the art of dance, whether it is a classical ballet in the West or the ethnic dance produced under the support of Eastern aesthetics, it is very important for the actor's body in the performance. The dance system takes geometric graphics as the aesthetic principle, and through expansion and suppression of itself, thereby achieves a composition that conforms to aesthetics [1]. With the expansion of the body's

range, the emotions passed to the audience will effectively improve. The flexibility enables the dancers to enlarge their vision from the perspective of the audience.

In the context of the continuous development of the dance art system, in addition to paying attention to the final artistic output of dancers, people pay more attention to the training methods with dancers. People hope to ensure the scientific trainee in this unique profession that needs to be expressed in the body. Through theoretical understanding and explanation of dance performance, skills, and physical exercise methods. As a result, the subject of dance science is formed to help students and coaches improve the quality of dance performance correctly and scientifically. Each individual's physical adaptation of dance art is different.

There exists a question on how flexibility can be scientifically assessed to determine its impact on the quality of dancers. Congenital joint relaxation, which seems to be an advantage in this profession, really makes dancers gain more than disadvantages in subsequent training.

This article aims to discuss the advantages and disadvantages of the future development of congenital joint activity and flexibility. In the previous article, it was mentioned that professional dance colleges will use several standards to measure whether the trainees are suitable for learning dance. The age of the students is generally between nine and ten years old. The inevitable injury in the training of strength is also a problem that the parents and coaches of the trainees pay attention to.

This study will take the analysis of the possibility of the hip joint as an example to conduct an in-depth analysis of subsequent changes caused by the congenital differences in joint activity and flexibility. The article uses the basic measurement of range of motion (ROM) to find the relationship between joint activity and flexibility [2]. The author hopes to evaluate the dancers through dance science and human science. The conclusions may be suitable for judging whether the trainees are suitable for professional dance learning from a new perspective, thereby reducing the possibility of injury. Under the requirement to meet the stretching needs of different types of dances, it will not cause damage under excessive relaxation of body ligaments and joints.

## **2. Congenital Joint Activity and Flexibility**

In the entrance examination and review of dancers in China, admissions teachers need to conduct a comprehensive inspection of them, basic proportions, flexible inspections, and coordinated tests through multiple rounds of examinations. Young students are in a period of development and often cannot accurately judge whether they can fully meet the follow-up standards of dance training and aesthetic requirements. In the current training system, no regular physical indicators are measured in their physical growth after the students enter the school. The various indicators will be unpredictable in subsequent training, especially the different uncertainty of the hip joints, causing the dance posture, the amplitude of the bouncing, and the opening and closing of the limbs. Therefore, it is necessary to combine dance training in human science and sports science to provide accurate data for the improvement of students in the later period.

### *2.1. Definition and measurement of congenital joint activity*

In dance training, students are often required to reach and adduct their joints, which requires coaches and students to be very clear about each joint activity. It is generally observed that joint activity has clinical importance when dealing with muscle-skeletal conditions [3]. The degree of joint activity is divided into passive activity and active activity. Due to the large joint activity, some students find it relatively easy to complete specific actions, and vice versa.

Dance is based on human movement, and the purpose of joint activity measurement is to clarify the most basic assessment items implemented by human movement, which will effectively improve the predictive predictability of dancers to develop physical training and other training. The joint activity of dancers is often greater than ordinary people, so it is necessary to measure and evaluate some trainees with limited joints. Human joint movements are limited by motion planes (sagittal planes, coronal plane, transverse planes) and movement axes (sagittal axes, coronal axes, transverse axes, vertical axes), and have high standards in measurement accuracy [2].

### *2.2. Definition and measurement of flexibility*

Dancers' flexibility is the main factor that supports their actions. Flexibility is closely related to age, body shape, muscle quality, etc., and the individual differences of flexibility are much greater than the activity of the joints, and they are specific [4]. Flexibility refers to the ability of muscles and ligaments to be able to extend, stretch, and curve freely when they receive external force. Students will bring the action of actively stretching the leg muscles and ligament to complete the high stretching action. The conventional measurement method will no longer be suitable for dancers' flexibility measurements. Except for conventional body flexion, standing or sitting partial extension, the Motion Analysis System, Electromyography (EMG), etc., should be added. To measure dynamic flexibility for dancers, and provide detailed data and analysis.

### *2.3. The relationship between congenital joint activity and flexibility*

The joint active activity mentioned earlier occupies the vast majority of dance movements, and it is a joint movement generated by the muscles of each student's individual. In active activity, muscles control joint movement through contraction or abduction, which is associated with flexibility.

Congenital joint activity is closely related to flexibility, and most of them are positive. Good congenital joint activity usually corresponds to the better flexible level, because the joints have a large range of exercise at birth or during growth. When dancers are limited in joint activity (but still greater than ordinary people), the flexible training effect will be reduced, and muscle and ligaments cannot be fully stretched within the range of joint activity. A compensation movement will occur in the unable-reached action, which may lead to a bad movement mode. Such students can improve this problem as much as possible through other auxiliary training, which will be mentioned later. Even if their congenital joint activity is limited, they can enhance the stretching ability of muscles and ligaments through flexibility-assisted training, thereby improving the flexibility level.

## **3. Research and Analysis of Dancers' Hip Injury**

### *3.1. Hip joint anatomy and motion characteristics*

The hip joint is one of the largest joints of the human body, and it is also the most commonly used joint of dancers. It connects the hip and femoral bone, which plays the role of supporting the body up and down. Hip joints distribute many muscles, including iliopsoas, gluteus maximus, quadratus lumborum, quadriceps, etc. They participate in the exercise of dancers to varying degrees. Whether it is a student or an experienced dancer, they should give priority to grasping the problem of exertion of the muscles around the hip joint during training, and this will largely help them complete the connection between the leg movements and the upper body.

Students should first understand the maximum passive activity of their hip joints, and they can measure their exterior angle values in a supine posture. The reference range of the normal hip outreach activity is  $0^{\circ}$  to  $45^{\circ}$ , and the upper part of the femoral neck is supported at the top of the acetabular fossa at the extreme posture. At this time, you should pay attention to the pelvic tilt, that is, the compensation movement [2]. For dancers, such a small range of activity is not enough, so the professional characteristics of dance make students need to master different combination methods. For example, the dancers need to control the stretching of the legs more than  $90^{\circ}$ . This requires not only active outreach, but to combining multiple ways of force, which is indispensable. When the passive activity of the outreach reaches the limit, the front end of the femoral neck is positive facing the acetabular fossa through the hip joint. After avoiding the hip-opening fossa, the exterior range can be significantly increased. In cooperation with the dancer's trained iliopsoas and gluteus maximus, it will be able to reach the visual-super stretch of the dance aesthetics.

### *3.2. The effect of congenital joint activity and flexibility on hip joint injury*

Injury is the most common and inevitable in the dance profession. Pulled muscle caused by the problem of exertion, or bone damage caused by lack of ability when completing difficult techniques, etc., often

plagued students and coaches. Among them, the most common injury occurs in the hip joint. In the previous article, the hip joint as the most widely used part of the dancer has assumed a stable and load role. Congenital joint activity and flexibility have great guidance for injury to this part. When the hip activity is limited, high-intensity practice, external rotation, and flexibility training, most of them will be counterproductive. The cycle of biomechanics of functional disorder expounds on the problems faced by the dancer during the injury stage. Due to the continuous stimulation of the hip joints during the training, it has caused changes in biomechanics and painful or structural injuries [5]. After that, the dancers instinctively avoid pain points, which reduces muscle function. The hip joint will further lack muscle protection, resulting in the reactive tension of the dancer, the muscle will be continuously tense, and then the same part of the injury will occur again [5].

As mentioned earlier, limited joint activity is often accompanied by poor flexibility, and flexibility is critical to preventing hip injury. Having muscle stretching ability and elasticity of soft tissue around the hip joint will help reduce the pressure and tension, improve the stability of the hip joint, and at the same time avoid compensation movement to the greatest extent. Dancers' specific flexibility training methods will be explained in the final chapter.

In dance training, there is another type of student-injured hip joint. Their congenital joint activity is very relaxed, providing great convenience and shortcuts for professional training and flexible training. This type of student is the opposite of the former. With the support of a larger joint activity, it can be easier to complete the large dance action. Such students are considered to be in line with learning dance when recruiting dance colleges, and they have reached the standard of dance in both hip outreach, external rotation, or internal collection. Often, those students have suffered a lot of disadvantages in subsequent training. The current teaching system overlooks the follow-up results caused by the large joint activity. This symptom is also known as congenital joint relaxation, which is a congenital disease, often accompanied by congenital ligament relaxation.

The joint ligaments of such students generally lack elasticity, and they usually increase the possibility of joint injury or even dislocation. According to statistics, among young dancers, people with congenital joints relaxation are quite wide [3]. Dance students injured with congenital joints relaxation even more than those of the limited joint activity which mentioned earlier. In dance performances, muscles and bones play a complementary role. After the joint passive activity has a normal range, it will drive the force through the muscles to reduce the friction of pure joint and bones. Students with excessive joints activity usually do not actively or use surrounding muscle tissues in a small amount during training, and their visual extension is still even greater than other students, which is relatively convenient and easy for them. Under the accumulation of training for years, the muscle quality of these students has not received the required growth, especially reflected in the hip joints with high requirements in dance movements. When they are used to driving the stretching movements of the legs through pure bone and joint motion, whether their inner or outer muscle group will not be able to protect the stability and buffer of the hip joint, leading to hip joint wear or dislocation.

### *3.3. Types and incidences of dancers' hip injury*

Hip joint injury is divided into multiple types, and the incidence of dancers is significantly greater than ordinary people. In dance training, the incidence may be affected by multiple factors. It may be caused by the joint movement and flexibility mentioned earlier. If high-intensity training lacks buffer may cause fatigue injury. The author conducts questionnaire surveys of various subjects in the Beijing Dance Academy in China, including ballet, Chinese dance, international standard dance, etc. The age range of the survey is 9 to 18 years old. After the survey and analysis, it was found that under the combination of all dances, the highest incidence of injury site was the hip joint, followed by ankle joints. Therefore, this chapter mainly analyzes the type of hip joint injury.

The most common injury among students is the strain or sprains of the iliopsoas fascia, which accounts for 63 % of the number of hip injuries because it is suffering from greater pressure in training. When students train in dance repertoires, often due to various uncertain factors required, causes sudden bending of hip joints, and excessive stretching of hip joints may also cause strain of iliopsoas fascia. At

the same time, the improper movement made by the students when they did not master the technical requirement, increased the risk of injury to the iliopsoas fascia. The occurrence rate of synovitis often occurs in the early stages of osteoarthritis [6]. Due to frequent daily dance activities and repetitive training, the hip joint will be affected by inflammation. Studies have shown that synovitis is related to poor hip structural function, that is, dancers with limited joint activity may be more likely to have synovitis [7]. Dance movements can increase the pressure inside the joints, and at the same time, the friction of the joint surface may increase, thereby increasing the risk of dancers forming synovitis. The accompanying pain will lead to further limited joint activity. When dealing with dance training, a small number of students will involve high-intensity hip joint movements and heavy pressure. In the case of severe wear, the cartilage on the acetabular fossa and neck of the femoral is harmed. Those students cannot practice jumping and hip joint rotation action with the same intensity after injury.

Hip dislocation and femoral head necrosis are caused by long-term training, there are almost no trainees between the ages of 9 to 18, only individual cases, such as congenital hip dislocation. Congenital hip dislocation is widely increasing among women. Due to the dysplasia of the hip joint during the fetus, the femoral head is not fully embedded in the acetabular fossa. This condition will bring disadvantages to the dancer's career. The congenital hip dislocation has gradually received the attention of the dance profession in recent years. The characteristics of this disease are reflected in the limitation of the patient's hip activity, pain in the outreach and internal collection direction, and has a great impact on the training of dancers. With the growth of the student's body, people with this condition can only reform the hip joint structure through surgery. There is a long-term recovery after surgery. For professional dance students, it is very unfavorable. Femoral head necrosis is more common among adult dancers. In their professional training for more than ten years, oppression and injury caused by hip joints have accumulated to a certain extent. The long-term insufficient blood supply has led to the gradual death of the tissue around the femoral head, forming a serious hip joint problem.

#### **4. The Training and Prevention Strategy of Congenital Joint Activity and Flexibility**

For dancers, the fascia and muscles of hip joints and pelvis need to be strong. In the dance, single-legged standing, supporting power leg movement and stretching, or single-legged support as the axis rotation were usually used. The pelvis needs to support quite a large weight in training. In these actions, the weight of the hip joint will be twice of dancer's weight, and the techniques such as jumping need to bear three to four times. Strengthening flexibility can effectively reinforce the toughness and extension of fascia and muscles, provide dancers with dynamic and static stability, and minimize friction and injury at the hip joint as much as possible [8]. Although the joint activity caused by natural bone development cannot be changed, good flexibility can visually improve the dancer's movement range, and use muscles to drive joints to play the highest joint activity range that can be used. In recent years, more and more dance auxiliary training has joined the daily life of the students. Coaches have also tried to enhance the flexibility of the students in the most scientific methods, instead of relying on the most primitive and most injured methods, which is leg pressing. In the process of contacting dance science and human anatomy, students gradually understand the body structure of a dancer, which is suitable for dancers' force.

##### *4.1. Training method and skills*

The dancers used the most widely-known auxiliary training, known as Pilates, and they penetrated the course from entry to senior dancers. Its founder was Joseph Hubertus Pilates from Germany, which developed Pilates training in the early 20th century. It is used as rehabilitation training with sports athletes and pregnant women in the early stage. Nowadays, after the continuous attempts and use of the coaches and the trainees of Pilate, it has successfully integrated into the field of dance and has become the best choice for dancers. Pilates is concluded in clinical trials to strengthen the effectiveness of improving flexibility and pelvic stability, and also enhance muscle activity [9]. The coordination of breathing is important for Pilates training. It mainly uses controlling movements and mobilizes multiple

outer and inner muscles together. For dancers, Pilates needs to emphasize the core muscle group, which is the best way to assist dancers in training flexibility.

The muscles are divided into two types in Pilates, which are respiratory muscles and action muscles, and the distribution of them is sometimes overlapped. Breathing is divided into chest breathing, abdominal breathing, and intercostal breathing. It is not right or wrong with each other, suitable for different training movements. Pilates emphasizes the training of core muscle groups, such as rectus abdominis, transversus abdominis, obliquus externus abdominis, obliquus internus abdominis, iliopsoas, and pelvic floor muscles. These inner muscles are responsible for balance and stability when used as respiratory muscles. Provide a larger scope of activity for motion muscle. When the core muscle group stabilizes, it effectively helps the pelvis to reduce weight and pressure, so that the friction of the acetabular fossa and femoral head are reduced. With muscle mobilization, the dancer reduces the heaviest-weight pelvis in the body, making hip joint minimize limitations to activity. It will enhance the possibility of increasing flexibility.

In the auxiliary training for flexibility, antagonistic muscle is the key. In simple terms, antagonistic muscles give active muscles in the motion of resistance. Each group of active and passive muscles in the body is called a set of antagonistic muscles. When active muscles contract, the other passive muscles will relax to ensure exercise. Taking the dancers to control their leg forward stretch of  $90^\circ$  as an example, at this time, the hamstrings and quadriceps are a set of antagonistic muscles. Quadriceps actively lift the legs. As the antagonistic muscle at this time, the hamstrings will be relatively relaxed to maintain the balance of force. However, in auxiliary training, coaches will ask students to train this group of muscles oppositely. The trainees lay their legs in the hands of the coaches, with an angle of  $45^\circ$  to the ground. The student's legs pressed the hand downward, and the coach cooperated with the student's upward resistance for half a to one minute. At this time, the quadriceps became an antagonistic muscle, in a relatively relaxed state, and the hamstrings became active muscles. This kind of training makes a set of antagonistic muscles have a strong contraction and relaxation stage and has obvious activation of muscle and ligaments [10]. The opposing force helps to balance the strength of the legs of the dancer, effectively enhancing the flexibility of the legs without harming the passive activity of the hip joint and maintaining joint stability. In Pilates, students often use special equipment to help them completely different types of training, and the equipment has greatly improved the flexibility of training. The antagonist muscle training mentioned earlier, with the help of the equipment, will not be limited to lying on the flat movement. Using the Pilates bed and the tension belt in the standing position, compared with the former, is more in line with the characteristics of dancing physical movement.

#### *4.2. Precaution and suggestions*

Due to the high rate of injury in dancers' training, dance therapy was set up to help the dancers recover quickly after being injured and return to the training class. In addition, letting dancers scientifically master precautions can greatly reduce the incidence of injury and prevent problems before they occur. However, pre-injury prevention has not been paid enough attention, and the corresponding medical assistance investment is limited. If the medical field can be linked to the dance profession, it will prevent potential danger and injury to dancers' movements and training, and also effectively extend a dancer's career, which is very efficient [11]. When integrating the dance profession in the medical field, the most important thing for dancers and coaches is to turn theory into practical training, and successfully apply it to their own body. Sports mechanics and physiology should gradually join, which can be divided into two types: academic lectures and practical courses. In academic lectures, mechanical forces allow students to understand the rationality of movements, and they can be refined into joint kinematics and muscle mechanics. Let the trainees be grasped by analyzing the performance of body mechanics to various parts, the size and direction of the force, and the action point of the body, can reduce the possibility of injury. Although physiology and sports mechanics are solved differently, theory is crossing each other. Let students contact physiology so that they can master how to relieve muscle fatigue and how the respiratory system can adapt to high-intensity training with dancers. Each individual has different optimization methods, which are determined by congenital bone development and muscle

quality. After fully grasping theoretical knowledge, trainees should discuss with teachers and enter the course for practical exercises to truly solve the problems of dance performance and movements. For students, there is a clear and controllable mind for their physical activities during training, which will be the best injury precaution.

The physical function activation of students before class is important, also known as warm-up activities. There are many highly explosive muscle forces in dance training. If students use relatively complete pre-class activation and warm-up, it will effectively improve the outbreak level in the follow-up course and reduce muscle strain [12]. At present, most students are consciously stretching flexibly before class, and some joint outreach and extension can be performed in advance to increase the range of joint activities in the follow-up course. Students are generally lacking in muscle activation. The author takes the hip joint as an example to achieve muscle stability and activation. For the stability of the pelvis, there are two groups of muscles to help balance. Core muscle groups, hamstrings, pelvic floor muscles, gluteus maximus, etc. are responsible for posterior pelvic tilts. Students can activate this part of the muscle group through training such as abdominal and back muscles, squats, and Pilates training. On the contrary, the latissimus dorsi, multifidus muscle, rectus femoris, sartorius, etc. are responsible for anterior pelvic tilts, which can be activated by side-raising legs and waist stretching. After the students complete the muscle activation through this structure, they can consciously complete the neutral position and stability of the pelvis in subsequent training, giving the hip activity and lower limb flexibility in the best motion state.

## 5. Conclusion

To sum up, the importance of innate range of motion and flexibility in dance training is self-evident. Studies have shown that limited range of motion is often accompanied by poor flexibility, which plays a key role in preventing hip injuries. However, excessive range of motion may also lead to drawbacks in subsequent training, especially in trainees with congenital laxity of range of motion, and may increase the risk of joint dislocation or injury. Therefore, in dance training, it is necessary to comprehensively consider the innate range of motion of the trainees to formulate a personalized training plan, which can not only improve the range of motion but also avoid joint damage. In addition, the hip joint is subjected to greater force and stress in the dancer's body, so special attention needs to be paid to the health of the hip joint during training. Common hip injuries include strains or sprains of the iliopsoas fascia, synovitis, etc., which may affect dancers' training and performance. Enhancing flexibility training, it can effectively strengthen the toughness and extension of fascia and muscles, provide dynamic and static stability, and reduce the risk of friction and injury at the hip joint. By comprehensively considering factors such as congenital range of motion, flexibility training, and hip joint health, dance training can be carried out more scientifically and effectively, providing a better guarantee for dancers' physical health and performance quality. In the future of dance training, the process of development and growth of students' bodies, should be combined with the continuous changes of bone and joint muscles, delve into the corresponding scientific measurement, and then adjust the follow-up targeted training. Under the combination of dance art and medical science, dance science can be very reasonable in traditional dance training. Fully grasp the growth or weakening of students' ability at each stage to achieve reasonable scientific training.

## References

- [1] John Ma. Introduction to the dance. Culture and Art Publishing House. 2004: 232.
- [2] Kellchiro S. Guidelines for measuring joint range of motion. Posts Telecom Press.2022:2-9: 150-151.
- [3] Wolf, J. M., Cameron, K. L., Owens, B. D. Impact of joint laxity and hypermobility on the musculoskeletal system. JAAOS-Journal of the American Academy of Orthopaedic Surgeons,19(8), 463-471.
- [4] Harris, M. L. Flexibility. PWSEPhysical Therapy, 1969, 49(6), 591-601.

- [5] Nick A. Injury prevention and management for dancers. Beijing Science and Technology Press.2022:61.
- [6] Wei Y, Wulin K, Puwei Y, Xun L, et al. Research progress on the role of synovitis in the pathogenesis of osteoarthritis. Chinese Journal of Rehabilitation Theory and Practice, 2015, 21(05), 530-533.
- [7] Matthiessen A, Conaghan P G. Synovitis in osteoarthritis: current understanding with therapeutic implications. Arthritis research & therapy, 2017, 19, 1-9.
- [8] Evan O. Corrective exercise solutions to common hip and shoulder dysfunction. Posts Telecom Press. 2020: 99.
- [9] Bernardo, L. M. The effectiveness of Pilates training in healthy adults: An appraisal of the research literature. Journal of bodywork and movement therapies, 2007, 11(2), 106-110.
- [10] Belanger A Y, McComas A J, Elder G B C. Physiological properties of two antagonistic human muscle groups. European Journal of Applied Physiology and Occupational Physiology, 1983, 51, 381-393.
- [11] Andrade C. What are stated gaps in injury prevention and treatment available on college campuses for dancers? 2021.
- [12] Silva L M, Neiva H P, Marques M C, et al. Effects of warm-up, post-warm-up, and re-warm-up strategies on explosive efforts in team sports: A systematic review. Sports Medicine, 2018, 48, 2285-2299.