

Help Young Ballet Dancers with Knee Injuries in Training

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Abstract. The improvement of dance art standards has put forward higher requirements for dancers' biological and physical needs. The knee, as a key body part, may seriously affect the dancer's career and daily life once injured. Therefore, it is particularly important to design special auxiliary training equipment to protect the knee. Based on this, this paper summarizes the causes of knee injuries, reviews the measures taken by previous scholars to solve knee injuries, and introduces a training instrument to prevent knee injuries in young ballet dancers, which exercises leg muscles by providing resistance when the knee is bent, reduces knee pressure, and is equipped with a display to track training progress. Following the analysis and discussion section, two auxiliary training methods using the instrument are proposed to strengthen the dancers' abdominal core and hip muscle groups and improve the control and stability of the leg muscles. The results show that despite the increasing aesthetic and athletic demands of dance, the biological and physical needs of dancers must be carefully considered, and effective preventive measures must be developed.

Keywords: Ballet; A knee injury; Instrumental therapy.

1. Introduction

Dance, as a form of sports and art, plays an inevitable role in our daily lives and is becoming more and more popular. However, since it's full of great difficulties in achieving both artistic beauty and sporty force, young dancers, especially ballet dancers, often get injured under long and strict training. According to Ekegren and his colleagues (2013), bony injuries and those in knees stand for the highest frequency among dance students and take the most time to resolve. These kinds of injuries can make dancers less flexible than those who have not experienced those injuries (Reid et al., 1987) and leave a negative effect on their later daily lives. What's more, the fact that most dancers do not seek medical care for injuries and perceive them as an ineluctable result of their career makes the harm incidence worse and worse (Kerr et al., 1992). Therefore, some breakthroughs in techniques and solutions are required to solve this issue. In this case, this essay will introduce a brand-new design that helps young ballet dancers with their knees' health in their training process, explaining how this instrument can achieve its intended effect.

2. Literature Review

Injury is a common issue among ballet dancers, particularly in knee joints. This is because some specific ballet dance movements will exert considerable stress on the knees. Movements such as jumping high airborne and quick landing, which require extreme flexion, extension, and rotation of the knee joint, often exceed the range that the knee can sustain in everyday activities, and even a slight deviation of landing can lead to irreversible harm (Liederbach et al., 2008).

2.1. Integrated Factors in Dance Lead to Knee Injuries

First, for the sake of the high demand for specific dance movements, repetition-caused overuse, like spending a considerable amount of time dancing en pointe (on her toes) and rotating, can lead to tendinitis, neuritis, and stress fractures (Schon et al., 1996).

Second, many high-level movements require dancers' extreme ability in muscle control, strength skills, endurance, overall flexibility, joint stability, and neuromuscular coordination (Malkogeorgos et al., 2011). The absence of any of those abilities can make the movement incomplete and cause gradual or sometimes intensive injuries.

Moreover, a lack of proper and sufficient warm-up is another potential risk of injuries (Southwick et al., 2017). They conclude that it's of great necessity for dancers to warm up in both static and dynamic ways to lubricate the joints before classes or rehearsal.

In sum, this essay will focus the most on the second potential factor: muscle ability. This is because the repetitive movements in dance are always inevitable for dancers to perform, and the incorrect and insufficient warming up is relatively simpler to resolve. Thus, the central resolution for protecting dancers' knee injuries involve researching on methods to build up their controlling muscle associated with knee joints.

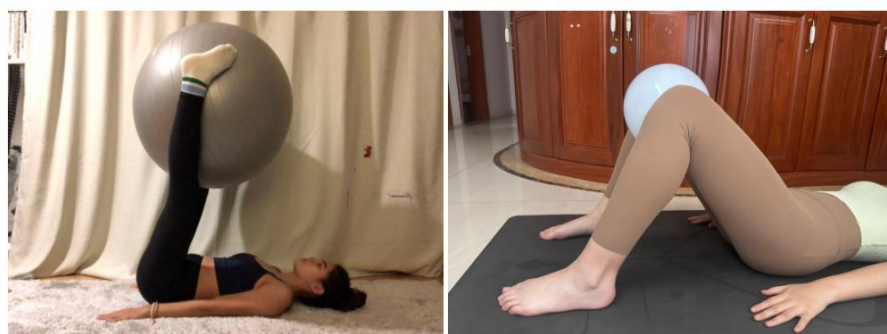
2.2. Previous Attempts to Address Knee Injuries in Dance

One of the implemented research studies to address the issue is injury prevention training, which includes strengthening hip and thigh muscles, exercising flexibility, and training balance. A study conducted by Fotaki and his colleagues (2021) found that dancers who participated in a structured biomechanical approach, which aims to train strength, experienced fewer knee injuries. However, this program lacks time, resources, and specific research details about the target bio-structure and requires dancers' adherence, which seems impossible for them to stick to.

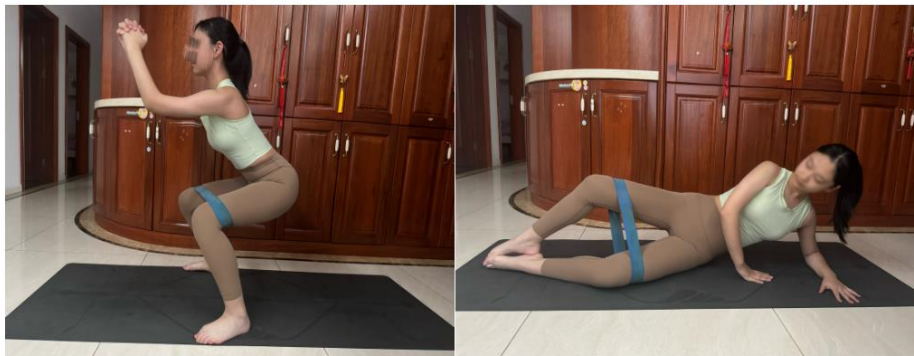


Figures 1. Demi plie position and grand plie position are bio-mechanical structured practices researched by Fotaki and his colleagues (2021)

The other potential attempt is the use of certain equipment, like applying elastic bands and free weights to create resistance or exercise balls to force dancers to use their thigh muscles rather than overuse their knees. However, studies have found that the equipment is always cumbersome and restrictive in developing muscle strength and control (Kadel, 2006). For example, the exercise ball is always hard for users to control due to its circular, slippery, and very elastic properties. As for elastic bands, people cannot freely adjust the suitable strength for them to use, and this can limit people's movement to a great extent.



Figures 2. Intended use of exercise balls in training to prevent knee injuries



Figures 3. Intended use of elastic bands in training to prevent knee injuries

2.3. Relevant Findings in Physics and Biology

From a physics perspective, certain dance movements, like merely the jumping and landing techniques, can exert significant forces on the knee joint. For instance, when a dancer performs a jump with a single-leg landing, the force on the knees upon landing can be measured up to 12 times their body weight (Liederbach et al., 2008). This extreme force will force pressure on the knee's ligaments and tendons, increasing the risk of injury. In this case, understanding these forces can facilitate the development of techniques and equipment to achieve impact more effectively.

For biology, young dancers' musculoskeletal systems are still developing, making them more susceptible to injuries due to overuse or improper use of the systems. Hincapié et al., (2008) note that dancers under intensive dance training at a young age may lead to long-term musculoskeletal health consequences. Research suggests that institutes need to cooperate much more supplemental training for dancers and pay much more attention on training effect to satisfy the physiologic standard of a dancer (Twitchett et al., 2009).

3. Methodology

Based on the background above, this essay will introduce a brand new instrument that helps prevent young ballet dancers from knee injuries based on consideration of their muscle training. This instrument is made up of two plates, a rod connecting them, and a cylindrical cover over the rod. The users need to fix the bigger plate under their thighs and the smaller one under their lower legs. They should try to fold the plates by bending their knees, but there will be strong resistance. The cover over the rod will be made of rubber to make users feel comfortable without getting stuck if it comes into contact with their knee sockets. The instrument is connected by a threaded rod, which is wrapped up in a compression spring that is really strong. One side of the rod is attached by a rotary knob which can be rotated to compress or release the spring. Thus, the force that dancers need to exert to fold the plates can be changed in order to satisfy their different training requirements. On the other side of the cover, there is a monitor displaying the force that users adjust and counting the number of folds that users make. This will help them clarify their training objective and strengths. The size and shape of the two plates are designed to fit on users' leg lines, like the camber in the middle. There are elastic bands over the places that allow users to fix the instrument under their legs without moving it off.

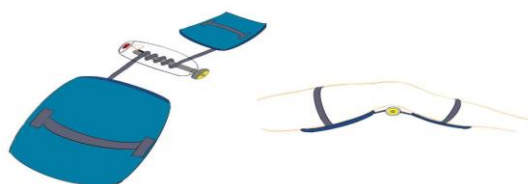


Figure 4. Design of the training instrument from top and side view

For the functioning of this instrument, since it creates resistance for people to bend their knees, they will exert force on the muscles of their legs to move rather than unintentionally put all pressure on their knee joints. This will protect their knees to a great extent and exercise their legs' muscles, which helps with their additional dancing movement without this instrument. Furthermore, the cylindrical rubber cover is made according to the size of people's knee sockets. Thus, it can make sure that when people are bending their legs, the cover will be stuck right in their sockets to create a space in their knee joints rather than completely folding. This not only greatly prevents injuries but also allows users to use it comfortably.

4. Analysis and Discussion

Since knee injuries can be caused by multiple factors like muscle strength imbalance, overuse, and incorrect use of a physical instrument (Malkogeorgos et al., 2011), even some of the most simple and basic movements like any plie positions or standing on tiptoe can make some negative influences. Therefore, supplementary exercise training with efficient physical instruments must aid in alleviating such issues. This essay exemplifies two auxiliary training methods with the instrument introduced above:

4.1. Training 1: Abdominal Crunch With Knees Bending

In this training movement, the purpose is to exercise the strength of the abdominal core muscles based on the necessary assistance of the legs' strength. When doing abdominal crunch, dancers will place the knee trainer at the bend of the knee so that their thigh and calf will be forced to bend in order to maintain balance while curling themselves up. This can also help them find the downward strength of the sacrum so that the abdominal core can be fully practiced.

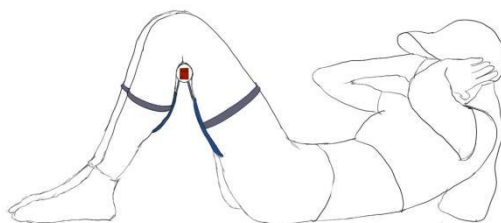


Figure 5. Approximate image for training 1 with knee trainers

4.2. Training 2: Leg Curl From Hip Abduction External Rotation To Posterior Extension

This movement aims to enhance the extension and command of hip muscle groups, reinforcing the control and stability of leg muscle groups. When the trainers shift their leg limbs from hip abduction rotation to extension, they often pay more attention to the hip muscle group, and the leg strength will be ignored, which makes their legs totally a burden. This can greatly weaken the purpose of hip muscle group training. Placing the knee trainer in the knee socket can make the dancers focus more on the leg muscle group and strengthen the control and stability of the leg muscle group so as to train their holistic muscle balances.

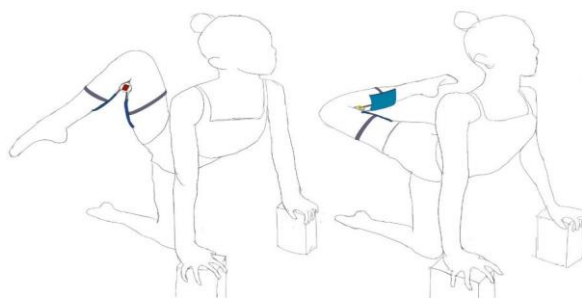


Figure 6. Approximate image for training 2 with knee trainers

5. Conclusion

While the aesthetic and athletic requirements for dancing are increasingly demanding, the biological and physical concerns of it should also be considered seriously, and solutions should be figured out. Since knee joints are one of the most crucial body structures and injury can lead to severe consequences to a dancer's career, even the rest of their life, developing a physical instrument with a specific assistant training process is of great need. This essay introduces an innovative design of a knee training instrument, composing both physiological needs and dance theory. Auxiliary training methods are also recommended to guide for the most effective way to mobilize the generated muscles around knee joints for protection.

Besides, potential future research is needed to test the utility and effectiveness of this instrument and the training results with its aided training approaches. Modification based on those experiments is also required to better fulfill dancers' anatomical mobility and dance instructions.

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