RESEARCH ARTICLE

# The current situation of sport injuries among high-level competitive aerobics athletes and the effect of rehabilitation training on sports injuries

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**High-level competitive aerobics competition in the difficult technical movements and the completion of standardization requirements increase the risk of injury of athletes. Sports injury has a negative impact on athletes' training and competition. This study aimed to find a reasonable way to prevent sports injury in the development of high-level competitive aerobics. 200 student athletes including 116 males and 84 females with an average age of 24.5 years old, and an average training period of 6.2 years, who participated in the National Aerobics Championships in Beijing, China from June 2022 to June 2023 were continuously followed up. The number and injury location of participated athletes were recorded. 57 of the 79 ankle injury athletes were involved in this study and were divided into two groups according to the selected treatment methods. The control group was treated with short-wave and ultrasonic therapy, while the experimental group was treated with short-wave and ultrasonic therapy + comprehensive rehabilitation training. The effectiveness of treatment, length of symptom relief, pain, swelling, and ankle function were recorded. The results showed that injury incidence among 200 high-level competitive aerobics athletes was 86% with the trend of the higher the sport level, the lower the likelihood of injury. Pre-competition training had the highest injury rate and post-competition recovery training had the lowest injury rate. Athletes' injuries were mainly concentrated in the ankles, lower back, wrists, and knees. Other parts of the injury such as shoulder, elbow, *etc*. accounted for a lower percentage. To the ankle injury groups, the experimental group had a higher total effective rate of treatment than that in the control group ($P < 0.05$). The times for the swelling, pain, and pressure to be relieved in the experimental group were significantly shorter than those in the control group. The visual analogue scale (VAS) scores of the experimental group and the degree of swelling of the affected part were significantly improved compared with those of the control group. The results confirmed that high-level competitive aerobics athletes had a high rate of sports injury during training, and the rate of ankle joint injury was the highest one. Rehabilitation training combined with short-wave and ultrasound treatment could effectively alleviate the pain level of ankle joint sports injury and promote faster recovery of the ankle.**

**Keywords:** competitive aerobics; sports injuries; athletes; rehabilitation.

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## Introduction

Since China's convergence with the international aerobics field, domestic competitive aerobics has made remarkable progress on the basis of continuous attempts and practices and has demonstrated outstanding performance in world competitions [1]. With the rapid rise of China's

competitive aerobics career and the continuous change of competition rules, competitive aerobics is developing in the direction of high difficulty technical movements and high standard of full set completion, which put forward higher requirements on the physical ability, skills, and psychological quality of high-level competitive aerobics athletes [2-4]. The high-level competitive athletes refer to those who graduated from a senior secondary education school, obtained a national second-class athlete's certificate or above, and won a team event at or above the provincial level in high school as the top six main players, or the top three in individual events. To gain an advantage in competitions, these competitive aerobics athletes need to undergo more systematic, rigorous, and specialized training [5]. However, prolonged high-intensity training challenges the physiological and psychological limits of the human body and increases the risk of sports injuries. In the increasingly competitive aerobics arena, the gap between high-level athletes is negligible, and how to avoid sports injuries has become a key factor affecting excellent performance [6].

The training of high-level competitive aerobics athletes is a long and complicated process, which requires a lot of human and material resources [7, 8]. Once an injury occurs, it will directly or indirectly affect the athlete's normal study and life, limit the systematic and continuous nature of training, thus affecting the maintenance and improvement of athletic performance, and may even lead to the premature end of the athlete's competitive career, resulting in a waste of talent [9-11]. Injured athletes may insist on training, but they are plagued by injuries, which makes it difficult to break through the technique of difficult movements and restricts the improvement of competitive level [12]. Therefore, how to take positive and effective measures to solve the problem of sports injuries during aerobics training is the key to the success of excellent coaches. Sports injuries are an urgent problem in competitive sports, especially for competitive aerobics athletes, where they may affect their competitive level and quality of life [13]. By studying sport injuries in high-level competitive aerobics athletes, it is possible to understand the types, incidence, and causes of injuries, so that coaches and athletes can be provided with targeted injury prevention measures [14, 15]. In addition, the research on sport injuries can help to improve athletes' physical fitness, optimize training methods, reduce the risk of sports injuries, and contribute to the sustainable development of competitive aerobics programs.

How to reduce the occurrence of sports injuries of high-level competitive aerobics athletes is one of the important issues that need to be solved urgently in the development of competitive aerobics in China. The purpose of this study was to enhance athletes' understanding of rehabilitation training and to provide theoretical and practical guidance in this field to promote the improvement of aerobics competitive skills and performance of middle school students. Through on-the-spot observation and questionnaire investigation, this study analyzed the sports injuries and main injury factors of Chinese professional aerobics athletes. Through the results of this study, scientists in the sports injury field could put forward prevention, treatment, and rehabilitation measures, intervene in advance, reduce or eliminate the factors that might lead to injury, and ensure that athletes could recover quickly after injury.

## Materials and methods

### Research subject selection

200 high-level competitive aerobics athletes who are students at Beijing University of Chemical Technology (Beijing, China), Peking University (Beijing, China), Beijing University of physical Education (Beijing, China), Beijing Normal University (Beijing, China), Capital Institute of Physical Education (Beijing, China), East China Normal University (Shanghai, China), Tongji University (Shanghai, China), Jiangxi Normal University (Nanchang, Jiangxi, China), Yichun

College (Yichun, Jiangxi, China), Taizhou College (Taizhou, Jiangxi, China), Guangzhou Institute of Physical Education (Guangzhou, Guangdong, China), Xiamen University (Xiamen, Fujian, China), Xiamen Institute of Technology (Xiamen, Fujian, China) with the average age of 24.5 years old and the training period of 6.2 years were involved in this study. All subjects participated in the Beijing National Aerobics Championships and were followed up continuously from June 2022 to June 2023. The number and location of injuries were recorded in detail. According to the situation of sports injury, athletes were divided into injury group and non-injury group, and the differences in injury type, incidence, and injury site distribution were compared and analyzed. All procedures of this study were approved by the Ethics Committee of Capital Institute of Physical Education (Beijing, China). Among the participants, 57 of 79 athletes who suffered ankle injuries were additionally divided into experimental and control groups according to the treatment methods. Short wave and ultrasonic therapy were used in the control group, while shortwave and ultrasonic therapy plus comprehensive rehabilitation training were applied in the experimental group. A total of 31 patients were included in the experimental group including 21 males and 10 females with an average age of 26.1 ± 9.64 years old and an average course of 6.64 ± 2.54 months. There were 26 cases in the control group including 17 males and 9 females with an average age of 27.96 ± 9.61 years old and an average course of 6.51 ± 2.51 months. The patient's selection criteria included (1) patients and their families fully understood the content of the study and voluntarily signed the informed consent, (2) the patient participated in the national and above level events and was injured in the competitions, (3) no joint dislocation or fracture confirmed by X-ray, (4) ankle pain, swelling, and other symptoms appeared after the activity, which could be relieved after a short rest. The following conditions were excluded in this study, which were (1) suffering from serious chronic diseases or history of joint injury, (2) had undergone major surgery within half a year, (3) ankle X-ray results showed dislocation or fracture and other abnormalities, (4) contraindications to short-wave and ultrasound treatment.

**Treatments**

All the subjects were treated continuously for 3 months before the evaluation of the therapeutic effects.

**(1) Short-wave therapy**

The short-wave therapy employed the ENRAF Curapuls 970 short-wave electrotherapy instrument (ENRAF Nonius, Delft, Zuid-Holland, Netherlands) with the parameters setting as maximum output power 200 W, frequency 40.68 MHz, output wavelength 7.37 m. Opposing electrodes were used and placed on both sides of the injured ankle joints. The treatment was performed 15 minutes each time, 3 times per week, 1 month per course for 3 continuous courses.

**(2) Ultrasound treatment**

The ultrasound treatment was performed after the short-wave treatment using ENRAF Sonopuls 190 ultrasonic therapy device (ENRAF Nonius, Delft, Zuid-Holland, Netherlands) with continuous output mode. The ultrasound probe was directly perpendicular to the skin of the affected area to carried out contact mobile treatment with 2 cm/s circular or back and forth straight-line movements. The treatment was carried out 10 minutes each time, 3 times a week, and 1 month per course for 3 continuous courses.

**(3) Comprehensive rehabilitation training**

The comprehensive rehabilitation training included muscle strength exercise around the ankle joint (heel-heel method), whole body muscle coordination and lower limb stability training, and ankle dorsiflexion and plantarflexion, ankle internal and external rotation strength training. The muscle strength exercise was performed by lifting a 10 kg sandbag with each hand and holding it for about 60 seconds after lifting the heel. It was 20 times/group, 3 groups each time, aiming to enhance the strength of ligaments and muscles

around the ankle joint and to improve the stability of the ankle joint. The whole body muscle coordination and lower limb stability training was conducted when the patient's eyes closed and both hands naturally placed on both sides of the body, while lifted a foot. The patient was asked to try to maintain body balance and exchanged the foot when it was fatigued. The training was 5 minutes each time, 3 times per week. The ankle flexion and rotation strength training used BIODEX 3.0 isokinetic strength testing system (Biodex, Long Island, New York, USA) training program [16], which included dorsiflexion and plantarflexion 60°/s for 6 times, 120°/s for 8 times, 180°/s for 10 times, internal and external rotation 60°/s for 6 times, 120°/s for 8 times, 180°/s for 10 times. The training was performed 3 times a week for 3 months.

**Assessment of indicators**

**(1) Effectiveness of treatment**

The effectiveness of the treatment was assessed after three months of treatment. The significant effect was defined as the symptoms, such as swelling and pain of ankle joint, being basically improved with no effect on daily life. If the symptoms in the ankle joint were improved after the treatment, and the patients were able to take care of themselves with a slight impact on daily life, it was defined as effective. However, if, at the end of the treatment, the symptoms were not improved or even worsened after the treatment, and patients had a serious impact on daily life and work, it was defined as ineffective.

**(2) Duration of symptom relief**

The duration of symptom relief was record. The time difference between the two groups in the relief of symptoms such as swelling, pain and pressure were compared. The pain and swelling degrees assessments were done at the times of before treatment, in the first month of treatment, and at the end of treatment. The degree of pain was assessed by using visual analog scoring (VAS) with a total score of 0 – 10. The higher scores represented more intense pain. The degree of swelling of the injured ankle joint was measured by using a tape measure and compared with the healthy side. The difference was taken as the result with a larger difference indicating the more serious of the swelling.

**(3) Ankle function**

The assessment of ankle function was performed before the treatment, during the first month, and at the end of the treatment. The American Orthopedic Foot and Ankle Society (AOFAS) (San Antonio, Texas, USA) assessment system was used to systematically assess the ankle-hindfoot function with a total score of 0 -100. The higher the score was, the better the ankle joint function recovered.

**Statistical analysis**

SPSS version 25.0 (IBM, Armonk, New York, USA) and Microsoft Excel 2010 (Microsoft, Redmond, Washington, USA) were used for statistical analysis. The data was expressed as mean ± standard deviation. Student t-test and $X^2$ test were applied for difference group comparison with $P$ value less than 0.05 as significant difference.

## Results and discussion

**Basic information**

In a follow-up study of 200 college competitive aerobics athletes, 172 athletes were found to have sports injuries with an injury rate of 86%. Specifically, there were 43 athletes at the national level and above with 32 injuries and a 74% injury rate, 66 athletes at the national level one with 56 injuries and an injury rate of 85%, and 91 athletes at the national level two with 84 injuries and an injury rate of 92%. There was no significant difference in sex, age, and course of disease between the groups of normal control and injury. However, there was a significant difference between athletes of different skill levels and sports injuries ($P < 0.05$) (Table 1). Competitive aerobics is a highly difficult and beautiful sport. Although there is no intense physical confrontation, the complex and varied techniques and short-term high-intensity exercise also increase the difficulty of the sport,

**Table 1.** Comparison of sports injuries among athletes of different sport levels.

| Sports level | No. of people surveyed | No. of injuries | Injury rate (%) |
|---|---|---|---|
| National level and above | 43 | 32 | 74 |
| National level one | 66 | 56 | 85 |
| National level two | 91 | 84 | 92 |
| Total | 200 | 172 | 86 |

and sports injuries often occur [17, 18]. According to the injury rate data, there was a certain correlation between the injuries of college competitive aerobics athletes and the level of the sport. Overall, the higher the athletic level was, the lower the likelihood of injury occurred.

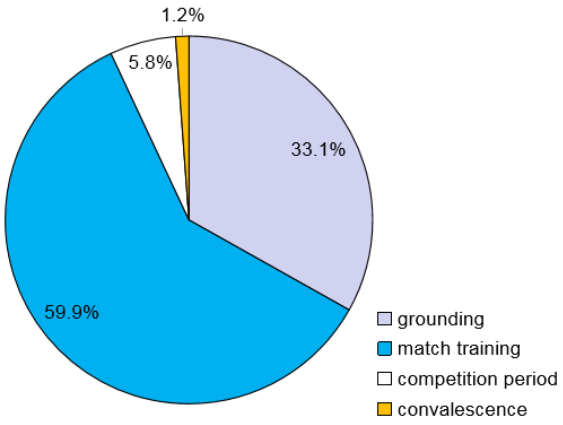


**Figure 1.** Sports injuries in competitive athletes in different training periods.

**Injury situation during training cycle**

According to the classification criteria of athletic training science and the training characteristics of competitive aerobics, the training cycle can be divided into four phases including the basic training period, the pre-competition preparation period, the competition period, and the recovery period. Among these four phases, the injury rates in the basic training period, the pre-competition preparation period, the competition period, and the recovery period were 33.1%, 59.9%, 5.8%, and 1.2%, respectively. Many athletes suffered more than one type of injury in a year (Figure 1). Some studies found that excessive training intensity was the leading cause of injury, accounting for 60%. Non-standard sports technology might lead to sports injury, accounting for 24% [19]. Therefore, how to reasonably control the training intensity and reduce the incidence of injury while ensuring the training effect is a problem that coaches and athletes need to pay attention to.

**Distribution of sports injury sites**

The proportion of injuries to the ankles, waist, wrists, knees, shoulders, elbows, thighs, calves, toes, and fingers all exceeded 10% (Figure 2). Competitive aerobics affected all parts of the human body with a wide range of injuries, mainly concentrated in the upper and lower limbs, especially the ankles, waist, wrists, and knees accounting for the injury rates as high as 45.9%, 41.9%, 40.1%, and 36.6%, respectively, which reflected that injuries to the ankles, waist, wrists, and knees were more common. The four difficulty action groups of competitive aerobics are dynamic strength, static strength, jumping and jumping, balance and flexibility. Support and jumping are the most important elements in the four action groups. Wrist, knee support, and ankle force are the key to complete these movements [20]. According to sports physiology and anatomy, wrist, ankle, and knee joints are the more fragile parts of the human body, therefore, the occurrence of sports injuries is closely related to the characteristics of the program and individual characteristics.

**Clinical efficacy**

The therapeutic effect of 57 patients was observed. The results of the study showed that the effective rate of treatment in the experimental group was 90.1% with a total of 28 patients obtaining good efficacy, while the effective rate of treatment in the control group

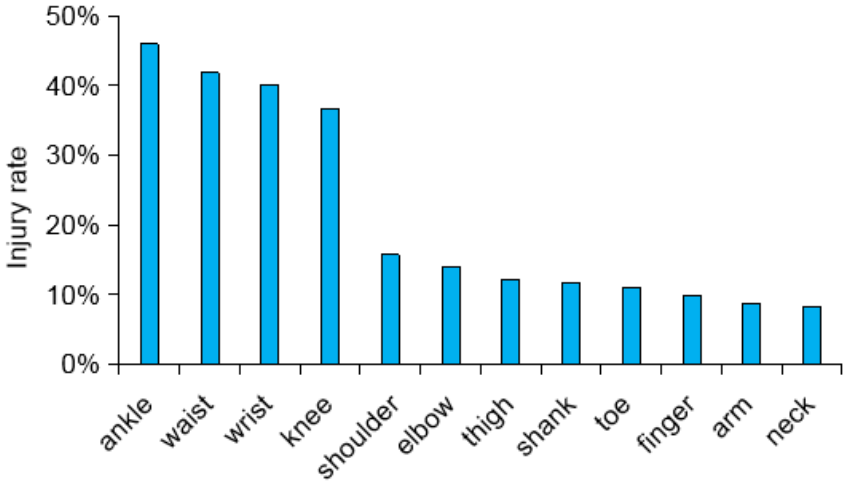


**Figure 2.** Injuries to different parts of the body in competitive athletes.

**Table 2.** Comparison of ankle symptom relief time between two groups of athletes [N (%)].

| Group | Case number | Significant effect | Effective | Ineffective | Total effective |
|---|---|---|---|---|---|
| Experimental | 31 | 19 (61.3) | 9 (29.0) | 3 (9.7) | 28 (90.3) |
| Control | 26 | 8 (30.8) | 11 (42.3) | 7 (26.9) | 19 (73.1) |
| Total | 57 | 27 (47.4) | 20 (35.1) | 10 (17.5) | 47 (82.5) |

**Table 3.** Comparison of individual ankle symptom relief time.

| Group | Swelling (days) | Pain (days) | Tenderness (days) |
|---|---|---|---|
| Experimental | 1.87 ± 0.79 | 2.55 ± 1.04 | 2.80 ± 1.39 |
| Control | 2.54 ± 1.01 | 3.92 ± 1.30 | 4.15 ± 1.10 |

was 73.1% with a total of 19 patients improving their conditions. The effective rate of the experimental group was significantly higher than that of the control group with significant difference ($P < 0.05$) (Table 2).

**Clinical symptom relief time**

The results of comparing and analyzing the time of the two groups in relieving the symptoms of swelling, pain, and pressure pain showed that the relief times of swelling, pain, and pressure pain in the experimental group were 1.87, 2.55, and 2.80 days, all of which were significantly shorter than that of the control group with significant difference ($P < 0.05$) (Table 3).

**Degree of pain and swelling**

At the initial stage of treatment, there was no significant difference between the two groups in terms of VAS score and degree of swelling. However, after the completion of treatment, the VAS score of the experimental group was 1.13, while the VAS score of the control group was 3.32. Moreover, the swelling degree of the affected area in the experimental group was 3.35 mm, which was significantly reduced compared with that of the control group of 6.38 mm ($P < 0.05$) (Table 4).

**Ankle joint function**

At the initial stage of treatment, there was no significant difference between the AOFAS scores of the two groups. However, at the end of the treatment, the AOFAS score of the experimental

**Table 4.** Comparison of pain and swelling levels before and after treatment.

| Group | VAS score | | Swelling (mm) | |
|---|---|---|---|---|
| | Before treatment | After treatment | Before treatment | After treatment |
| Experimental | 6.97 ± 1.84 | 1.13 ± 0.98 | 25.58 ± 4.86 | 3.35 ± 1.47 |
| Control | 6.92 ± 1.98 | 3.32 ± 0.93 | 25.73 ± 4.69 | 6.38 ± 2.11 |

**Table 5.** Comparison of ankle function before and after treatment.

| Group | AOFAS score | |
|---|---|---|
| | Before treatment | After treatment |
| Experimental | 52.87 ± 6.74 | 87.29 ± 8.11 |
| Control | 53.27 ± 6.41 | 72.04 ± 9.62 |

group was 87.29, which was significantly higher than that of the control group (72.04) with significant statistical difference ($P < 0.05$) (Table 5).

## Conclusion

The incidence of injury among 200 high-level competitive aerobics athletes was 86% (172/200), and the higher the sports level was, the lower the possibility of injury was. Pre-competition training had the highest injury rate of 59.9% and post-competition recovery training had the lowest injury rate of 1.2%. Athletes' injuries were concentrated in the ankles, lower back, wrists, and knees. Among them, ankle injuries were the most serious, accounting for 45.9%, while waist injuries accounted for 41.9%, wrist injuries accounted for 40.1%, and knee injuries accounted for 36.6%. Other body parts of the injury such as shoulder, elbow, *etc*. accounted for a relatively low percentage. In this study, 57 of 79 athletes with ankle injuries participated in the research and were divided into two groups according to the method of treatment. The results showed that the experimental group's total effective rate of treatment was higher than that of the control group ($P < 0.05$), while the experimental group's times for the reliefs of swelling, pain, and pressure pain were all significantly shorter than that of the control group. The experimental group's VAS scores and the swelling degree of the affected body part were significantly improved compared with that of the control group, while the AOFAS scores of the affected part in the experimental group were also significantly improved compared with that of the control group.

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