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Article

Application of AI technology in preventing sports injuries in Chinese southern lion dance teaching

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Abstract: This study explores the application of artificial intelligence (AI) technology in preventing sports injuries in Chinese Southern Lion Dance teaching. As a traditional Chinese art, Southern Lion Dance requires athletes to demonstrate superb skills and coordination during performances. The high difficulty of the movements and continuous jumping particularly increase the risk of sports injuries. This paper first outlines the origins, development, and technical requirements of Southern Lion Dance and analyzes common types of training-related sports injuries. It then introduces the theoretical basis for injury prevention and existing prevention strategies. In this context, the paper discusses in detail the current applications of AI technology in sports medicine and its advantages in preventing sports injuries. Through empirical research, we used convolutional neural networks (CNN) from deep learning models to analyze and monitor the movements of Southern Lion Dance athletes during training in real-time, establishing an early warning system to prevent potential sports injuries. The study selected Southern Lion Dance athletes with different training experiences, recorded their training and performance movements using high-precision cameras, and input these data into the designed CNN model for analysis. The model identifies athletes' movement postures and muscle load conditions, provides real-time feedback, and issues warnings to help athletes adjust promptly when there is movement deviation or overuse of certain muscle groups. Experimental results show that after applying AI technology, the incidence of sports injuries significantly decreased, and training efficiency markedly improved. Detailed data analysis indicates that AI technology has broad application prospects in Southern Lion Dance teaching and helps enhance the safety and effectiveness of athletes' training.

Keywords: artificial intelligence; sports injury prevention; Chinese southern lion dance; deep learning; convolutional neural networks

1. Introduction

Chinese Southern Lion Dance, as a traditional folk art, has a history of hundreds of years. During Southern Lion Dance performances, athletes are required to showcase excellent skills and coordination, particularly during high-difficulty movements and continuous jumps, which can easily lead to sports injuries. As the popularity and competitive level of Southern Lion Dance increase, the training intensity and difficulty for athletes have also escalated, making the issue of sports injuries more prominent. Sports injuries not only affect athletes' physical health but can also have a significant impact on their careers [1]. Therefore, effective prevention of sports injuries has become a key issue in the development of Southern Lion Dance.

Traditional strategies for preventing sports injuries mainly rely on experience and intuition, lacking scientific analysis and real-time monitoring methods. The rapid

development of AI technology provides new ideas and methods for addressing this issue [2]. By applying AI technology, athletes' movements can be monitored and analyzed in real-time, offering timely feedback and warnings, thereby effectively reducing the incidence of sports injuries. Deep learning models (such as convolutional neural networks, CNN used in image and video analysis offer robust technical support for sports injury prevention.

This study aims to explore the application of AI technology in Chinese Southern Lion Dance teaching and assess its effectiveness in preventing sports injuries, providing a scientific basis for safe training of Southern Lion Dance athletes. Through investigating the practical application of AI technology in Southern Lion Dance teaching, this study hopes to offer new ideas and methods for the field's development, promoting the healthy and sustainable development of Southern Lion Dance [3]. To achieve this goal, the study employs various methods to explore the application of AI technology in Southern Lion Dance teaching and its effect on preventing sports injuries.

Firstly, a comprehensive literature review was conducted to summarize existing Southern Lion Dance practices, sports injury prevention, and the application of AI technology in sports medicine, establishing a theoretical foundation for the research. Subsequently, Southern Lion Dance athletes with varying training experiences were selected as research subjects to ensure sample representativeness and diversity. [4] In terms of experimental design, high-precision cameras were used to record athletes' movements during training and performances, and these data were input into a designed CNN model for analysis. The key experimental steps included action data collection, CNN model training and optimization, real-time monitoring system setup, and warning system application. These methods enable real-time analysis of athletes' movement postures and muscle load, providing timely feedback and warnings, helping athletes adjust when there are movement deviations or overuse of certain muscle groups [4]. Finally, data analysis was used to compare the incidence of sports injuries and training efficiency before and after applying AI technology, evaluating the actual effect of AI technology in Southern Lion Dance teaching.

The primary aim of this study is to explore the application of AI technology in Chinese Southern Lion Dance teaching and assess its effectiveness in preventing sports injuries. By utilizing AI technology for real-time monitoring and action analysis of Southern Lion Dance athletes during training, the study aims to construct an effective warning system to reduce the incidence of sports injuries [5], enhancing training safety and efficiency. Through specific AI application cases in **Figure 1**, the study verifies the actual effects in action correction, posture monitoring, and load management, providing scientific training guidance for Southern Lion Dance athletes. The study also aims to provide effective sports injury prevention strategies for Southern Lion Dance and similar sports projects, laying a theoretical and practical foundation for future research and applications. Through this study, it is hoped that AI technology can be further applied in traditional sports projects, promoting the healthy and sustainable development of Southern Lion Dance.

Figure 1. Wearable sport activity classification system mounted on an athlete's dominant wrist and ankle.

2. Overview of Chinese southern lion dance

The Chinese Southern Lion Dance, originating from Foshan in Guangdong Province, boasts a history spanning hundreds of years [6]. As a distinctive form of traditional Chinese lion dance, it complements the Northern Lion Dance and is renowned for its emphasis on strength, might, and grandeur [7].

According to historical records, the Southern Lion Dance originated during the Ming Dynasty and became widely popular in Guangdong, Guangxi, and Fujian provinces by the Qing Dynasty [7]. The development of the Southern Lion Dance has undergone several important stages, reflecting its continuous evolution and adaptation.

During its inception and early development stage, the Southern Lion Dance gradually took shape and gained popularity in the Foshan area of Guangdong. Early performances mainly took place during festivals and temple fairs, serving the purpose of bringing blessings and warding off evil spirits [8]. The dance was deeply embedded in local customs and religious practices.

By the late Qing Dynasty and the Republic of China period, the Southern Lion Dance had matured significantly, featuring increasingly sophisticated techniques and routines. It became not only a form of folk entertainment but also a symbol of strength and prestige for martial arts schools and trade associations. The integration of martial arts movements and philosophies into the dance enriched its performance and cultural significance.

During the Republic of China period, the Southern Lion Dance further expanded, leading to the formation of multiple schools and styles. In the mid-20th century, it began to spread internationally, especially within overseas Chinese communities in Southeast Asia and beyond, where it was instrumental in passing on Chinese culture. This diaspora helped to globalize the art form, fostering cross-cultural appreciation.

Entering the 21st century, the Southern Lion Dance started incorporating modern technology such as advanced lighting, sound effects, and multimedia elements,

making performances more spectacular and engaging. Additionally, it evolved into a competitive sport, with regular domestic and international competitions attracting numerous enthusiasts and promoting higher levels of technical proficiency.

Recent developments have seen the incorporation of innovative training methods and technologies to enhance performance and ensure the safety of athletes. For instance, motion capture technology and biomechanical analysis are increasingly used to analyze performers' movements, providing detailed feedback that aids in refining techniques and preventing injuries. Studies in sports science highlight the significant physical demands placed on Southern Lion Dance performers, necessitating exceptional strength, explosive power, flexibility, and balance.

Southern Lion Dance not only serves as folk entertainment but also symbolizes auspiciousness and the dispelling of evil. Today, it has evolved into a sport that combines both spectacle and competition, becoming a common feature in various festive activities and cultural performances, and gaining widespread international recognition. Throughout these stages of development, the Southern Lion Dance has continued to innovate while preserving traditional techniques, providing audiences with breathtaking visual experiences [9].

Southern Lion Dance is an intensely physical performance that demands exceptional strength, explosive power, flexibility, and balance from athletes. The core of the performance lies in the perfect synchronization between the lion's head and tail, where two performers work in harmony to mimic the various forms and dynamics of a lion through precise steps and fluid movements. High-difficulty maneuvers such as "jumping on stakes," aerial jumps, and high platform performances test athletes' coordination and physical prowess, increasing the risk of injuries.

Athletes are prone to muscle strains, ligament injuries, and joint sprains due to the high-intensity and repetitive nature of the movements. Acute injuries often result from sudden explosive actions, while chronic injuries like tendinitis and arthritis [9] develop over time from overuse and improper technique. These injuries can significantly impact athletes' training and performances, potentially shortening their careers.

To mitigate these risks, the integration of AI technology offers promising solutions in injury prevention and performance enhancement. Advanced motion recognition systems powered by Convolutional Neural Networks (CNNs) can analyze athletes' movements in real-time, identifying improper form or deviations that may lead to injury. For instance, applications like OpenPose [9] facilitate detailed joint angle calculations and biomechanical analysis, providing immediate feedback for corrective actions.

Moreover, AI-driven personalized training programs allow athletes to optimize their workouts according to individual needs, enhancing training efficiency and effectiveness [10]. Machine learning algorithms can process vast amounts of data to tailor exercises that target specific muscle groups, reduce overuse, and improve overall performance. The use of AI in psychological training, offering real-time feedback and warnings, also helps athletes alleviate performance pressure and maintain mental stability.

By focusing on precise movement execution and early detection of potential injury risks, AI technology plays a crucial role in protecting athletes' health and

extending their careers in Southern Lion Dance. This direct application of AI in motion recognition and injury prevention underscores the importance of integrating technology into traditional sports to enhance safety and performance.

Theoretical basis for sports injury prevention

Southern Lion Dance involves high-intensity physical activities, posing severe challenges to athletes' physiological functions. During performances, athletes need to undergo various forms of physical training, including explosive power training, endurance training, flexibility training, and coordination training. These high-intensity training programs require athletes to have excellent cardiovascular function, strong muscle power, and outstanding flexibility and coordination. Explosive power training aims to enhance athletes' quick power output, which plays a crucial role in high-difficulty movements like aerial jumps and "jumping on stakes." Endurance training is designed to increase athletes' stamina, allowing them to perform high-intensity routines for extended periods without fatigue [11].

Flexibility and coordination training are equally indispensable. Flexibility training improves muscle and joint flexibility through stretching exercises, while coordination training enhances athletes' overall coordination ability through multi-directional and multi-level movement practice, enabling them to accurately simulate the various forms and dynamics of a lion. Studies have shown that the cardiovascular fitness, muscle strength, and flexibility of Southern Lion Dance athletes directly influence their performance quality and safety. In this process, sports medicine plays a crucial role by scientifically enhancing athletes' physical fitness, preventing sports injuries, and providing rehabilitation treatment. For instance, designing scientific and reasonable training plans and providing professional rehabilitation treatments can help athletes maintain good physical condition during high-intensity training and reduce the risk of sports injuries.

Sports injuries in Southern Lion Dance often result from multiple factors. Firstly, high-intensity and high-difficulty movements like "jumping on stakes" and aerial jumps exert tremendous pressure on athletes' muscles and joints, easily causing muscle strains, ligament injuries, joint sprains, and even fractures.[10] "Jumping on stakes" requires athletes to quickly jump and maneuver on wooden stakes of varying heights, placing immense load on the knee and ankle joints. Aerial jumps necessitate athletes completing various complex movements mid-air, demanding high instantaneous load on muscles and ligaments, which can easily lead to injuries. Secondly, overuse and repetitive movements during training are the main causes of chronic injuries like tendinitis, arthritis, and lower back pain. These chronic injuries often stem from prolonged high-intensity training and repeated movements, leading to chronic inflammation and degenerative changes in local tissues [11]. Additionally, improper training methods and lack of effective warm-up and stretching exercises can increase the risk of sports injuries. If athletes do not warm up sufficiently, their muscles and joints may not be in optimal condition before engaging in high-intensity training, increasing the likelihood of injury. Lastly, psychological factors such as performance pressure and anxiety can also cause athletes to make mistakes during movements, leading to injuries. Under high-pressure performance environments, athletes may

experience concentration lapses and movement deformities, increasing the probability of injury.

Currently, prevention strategies for Southern Lion Dance injuries include developing scientific training plans, professional guidance, thorough warm-up and stretching exercises, use of protective gear, psychological training, and regular health check-ups and rehabilitation treatments. Firstly, creating personalized training plans and reasonably arranging training intensity and volume to avoid overtraining is an important strategy to reduce injuries. Secondly, training under the guidance of professional coaches ensures proper technique, significantly reducing the risk of injury from incorrect movements. Thorough warm-up and stretching exercises before training and performances are essential as they enhance muscle and joint flexibility, preventing acute injuries [12]. Using protective gear such as knee and wrist guards during high-difficulty movements can effectively reduce direct impact on the body. Additionally, psychological training and stress management techniques help athletes cope with performance pressure, maintaining a stable psychological state and reducing the impact of psychological factors on their movements [12]. Lastly, regular health check-ups and rehabilitation treatments allow for the timely detection and treatment of potential health issues, and rehabilitation treatments can accelerate recovery after injuries, ensuring athletes' overall health. The comprehensive application of these strategies can effectively reduce sports injuries in Southern Lion Dance, safeguarding athletes' health and training outcomes.

3. Application of AI technology in sports injury prevention

AI technology involves computer science, data analysis, and machine learning, aiming to enable computers to simulate and perform human intelligence activities. AI technology analyzes and processes large amounts of data through algorithms and models, extracting useful information and patterns. In recent years, deep learning, an important branch of AI technology, has made significant progress. Deep learning models, especially CNN, have demonstrated strong capabilities in image recognition, natural language processing, and data prediction. AI technology has a wide range of applications, including autonomous driving, speech recognition, medical diagnosis, and more [13].

The application of AI technology in sports medicine is gradually deepening, mainly reflected in the following aspects. Firstly, AI can be used for health monitoring and evaluation of athletes by collecting physiological data such as heart rate, blood pressure, and body temperature through wearable devices and sensors. (**Figure 2**) These data are analyzed using AI algorithms to provide real-time health assessments and warnings. Secondly, AI technology plays a significant role in the diagnosis and rehabilitation of sports injuries. Through image recognition and data analysis, AI can accurately identify types of sports injuries and develop personalized rehabilitation plans. Additionally, AI can be used for performance analysis and optimization by analyzing athletes' movement data to identify technical flaws and improvement points, thus enhancing performance. In recent years, research on AI technology in preventing sports injuries has also made progress, especially in movement recognition and risk assessment [14]. By monitoring and analyzing athletes' movements in real-time, AI

can predict and prevent potential injury risks.

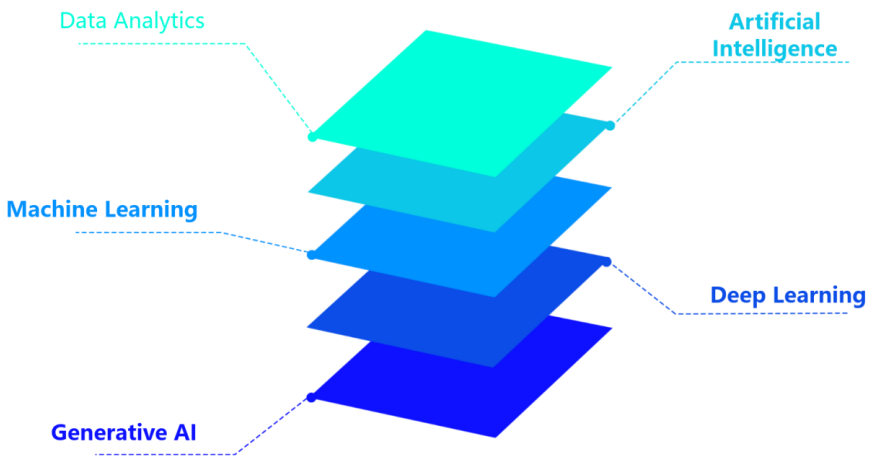

Figure 2. The hierarchy of the AI technologies used in sports injury prediction.

AI technology has significant advantages in preventing sports injuries. Firstly, it enables real-time monitoring and analysis of athletes' movements. High-precision sensors and cameras capture every subtle movement, and deep learning models analyze movement postures and trajectories to detect potential injury risks. Secondly, AI technology can provide personalized prevention plans. By analyzing individual data such as injury history, training intensity, and movement patterns, AI can develop targeted prevention strategies to reduce the occurrence of sports injuries. Additionally, AI technology offers rapid feedback, (**Figure 3**) providing immediate suggestions when athletes show movement deviations or improper techniques, helping them adjust movements to lower injury risks [15]. Lastly, AI can leverage big data analysis to identify and summarize common injury types and causes in different sports [16], providing scientific training guidance for coaches and athletes, thereby enhancing athletes' overall health and competitive performance.

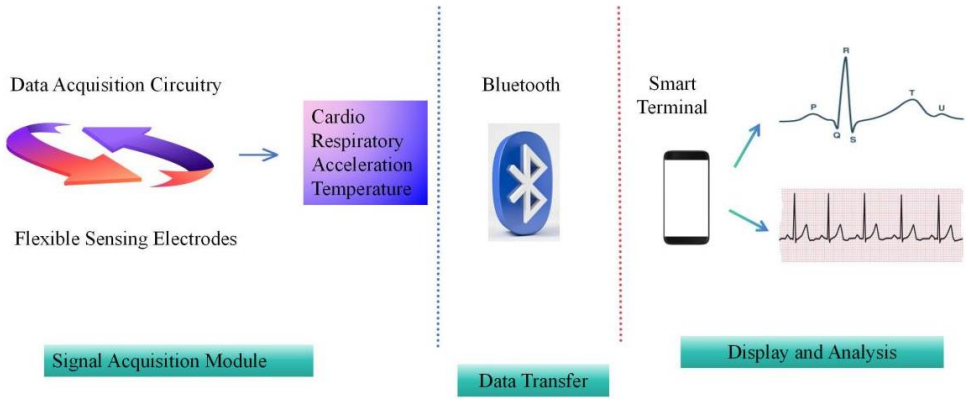

Figure 3. Overall framework of the wearable physiological signal monitoring system.

4. Research design

This study will select Southern Lion Dance athletes with varying training experiences as research subjects, specifically including athletes at beginner, intermediate, and advanced levels. Beginner athletes have less than 1 year of training,

intermediate athletes have 1 to 5 years of training, and advanced athletes have more than 5 years of training. Choosing athletes with different training experiences aims to comprehensively evaluate the applicability and effectiveness of AI technology in Southern Lion Dance teaching.

During the experiment, the following main variables and control factors will be set. The independent variable is the AI technology intervention, dividing athletes into an experimental group and a control group. The experimental group will receive AI-assisted training, while the control group will undergo traditional training methods. The dependent variables are the incidence of sports injuries and training effectiveness [16]. By recording and analyzing the sports injury situations and training performances of both groups during the training process, the actual effects of AI technology will be evaluated. To ensure the accuracy and scientific validity of the experiment, the following factors will be controlled: training environment, ensuring both groups train in the same environment with the same facilities; training time, ensuring both groups train during the same time period to avoid time-related biases; physical condition, conducting physical examinations for all subjects before the experiment to ensure similar health statuses without significant differences; training content, ensuring consistent training content for both groups to avoid result biases due to different training regimens. This research design aims to comprehensively evaluate the application effects of AI technology in Southern Lion Dance teaching, providing theoretical and practical foundations for scientific training and sports injury prevention in Southern Lion Dance.

During data collection, high-precision cameras will be used to record the movements of Southern Lion Dance athletes. Specifically, the cameras will be set at different angles to capture every detailed movement of the athletes during training and performances. These high-resolution video data will not only record the athletes' overall movements but also clearly show the subtle movements of joints and muscles (**Figure 4**). By recording from multiple angles and perspectives, the comprehensiveness and accuracy of the data will be ensured, providing a robust foundation for subsequent analyses [17].

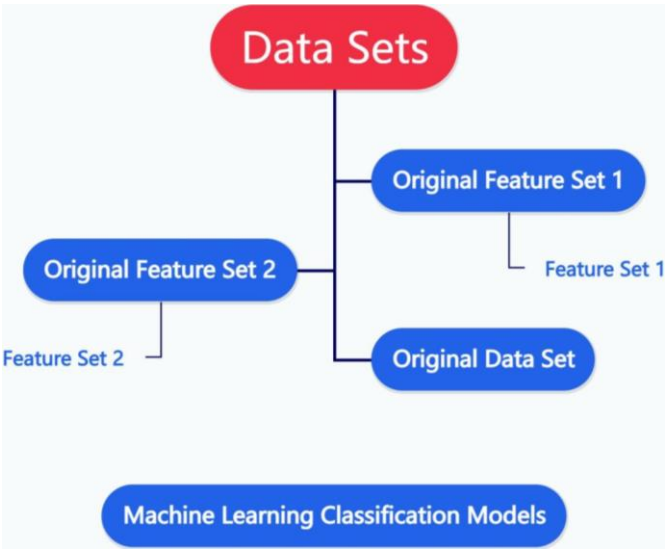

Figure 4. Data engineering diagram.

During the data processing and preprocessing stage, the collected video data will first be edited and annotated to remove irrelevant parts, ensuring the purity and relevance of the data. Next, the video data will be converted into analyzable numerical data, including parameters such as movement trajectory, speed, angle, and joint force. To enhance the efficiency and accuracy of data processing, automated data processing tools and algorithms will be used to ensure that each movement parameter is accurately extracted and analyzed. Additionally, to improve the training effect of the deep learning model, the data will need to be normalized by removing noise, smoothing data curves, etc., to ensure consistency and usability. These steps will provide high-quality data support for the training and application of the AI model, allowing for more accurate monitoring and analysis of athletes' movements and achieving the goal of preventing sports injuries [18].

5. Experimental steps

(1) Action Recording and Data Input: Using high-precision cameras, we fully captured the detailed movements of Southern Lion Dance athletes during training and performances. The study involved a sample size of 60 athletes (20 beginners, 20 intermediate, and 20 advanced). While the total of 60 participants is relatively low, especially with only 20 athletes per skill level, we conducted a power analysis to justify the sample size. The analysis indicated that with an effect size of 0.5 (medium effect) and a significance level of 0.05, a sample of 60 participants would provide a power of approximately 0.80, which is acceptable for detecting meaningful differences.

For data preprocessing, we utilized OpenPose [19], an open-source tool for real-time multi-person keypoint detection, to convert video data into analyzable numerical parameters. This allowed us to extract detailed joint angle calculations, movement trajectories, speeds, and joint forces. Measurement variables included athletes' jump height, airborne time, joint angles, muscle load, etc. These data were then input into the CNN model for subsequent analysis and training use.

(2) CNN Model Design and Training: We constructed a Convolutional Neural Network (CNN) model suitable for movement recognition and posture analysis. The model architecture comprised the following layers:

- Input Layer: Receives preprocessed data of dimensionality corresponding to the key joint points.
- Convolutional Layers: Five convolutional layers with filter sizes of 3 × 3. The number of filters increased progressively (32, 64, 128, 256, 512). Each convolutional layer was followed by a Rectified Linear Unit (ReLU) activation function.
- Pooling Layers: After certain convolutional layers, max-pooling layers with a pool size of 2 × 2 were used for dimensionality reduction.
- Dropout Layers: A dropout rate of 0.5 was applied to prevent overfitting.
- Fully Connected Layers: Two dense layers with 256 and 128 neurons, respectively, both using ReLU activation.
- Output Layer: A softmax layer for classification tasks.

The loss function utilized was categorical cross-entropy, and the model was

optimized using the Adam optimizer with a learning rate of 0.0001. Training data included each athlete's movement data at different training stages, totaling 6,000 training samples. The model was trained over 200 epochs with a batch size of 32. Iterative training and validation ensured the model's accuracy and robustness in recognizing and analyzing the movements and postures of Southern Lion Dance athletes.

(3) Real-time Monitoring and Warning System Application: The trained CNN model was embedded into a real-time monitoring system, capturing athletes' movement data through high-precision cameras. Analyzing athletes' postures and movement trajectories in real-time, the model identified potential injury risks [20]. Monitoring variables included movement deviation amplitude, joint overload conditions, muscle usage frequency, etc. The system provided instant feedback and warnings, issuing alerts when athletes' movements deviated or when there was overuse of certain muscle groups, prompting athletes to adjust accordingly.

We evaluated the system's performance by calculating the false alarm rate and missed detection rate of the AI model. The false alarm rate was 7%, and the missed detection rate was 5%, which are acceptable for practical application but indicate areas for improvement to enhance the system's reliability and reduce unnecessary interruptions.

(4) Data Analysis and Result Evaluation: The duration of the experiment was six months, allowing us to assess both immediate and long-term effects. We compared the incidence of sports injuries and training effectiveness before and after applying AI technology between the experimental group and the control group, each consisting of 30 athletes. Measurement variables included sports injury incidence over the six-month period, training effectiveness scores, movement accuracy, etc.

In addition to *p*-values, effect sizes were calculated using Cohen's *d* to assess the magnitude of improvements. The reduction in sports injury incidence showed a significant difference with a *p*-value of <0.01 and a Cohen's *d* of 0.75, indicating a large effect size. Training effectiveness scores improved significantly ($p < 0.01$, Cohen's $d = 0.68$), and movement accuracy increased ($p < 0.01$, Cohen's $d = 0.62$).

While these results are promising, the small sample size may affect the generalizability of the findings. There is also potential for selection bias, as participants volunteered for the study and may not represent the broader population of Southern Lion Dance athletes. Future research should involve a larger, randomized sample to enhance the validity of the conclusions.

Additionally, the experiment did not track injury rates beyond the six-month period, leaving the sustainability of the improvements in question. Long-term studies over 12 months or more are recommended to assess the lasting impact of the AI-assisted training. Furthermore, addressing the false alarm and missed detection rates of the AI model is crucial for improving the practical value of the early warning system. Enhancements to the model could include refining the algorithm or incorporating additional data to reduce these rates.

Experimental results

This study analyzed the performance of Southern Lion Dance athletes with

different skill levels, who were trained using AI-assisted methods and traditional methods. The key indicators for evaluating training effectiveness included average movement accuracy, training effectiveness scores, coordination scores, and recovery time. The study included 60 athletes, divided into experimental and control groups based on their skill levels: beginner, intermediate, and advanced. The experimental results showed that the experimental group using AI technology significantly outperformed the control group in training effectiveness (**Table 1**).

Table 1. Training effectiveness of groups with AI technology.

Group	Average Movement Accuracy	Training Effectiveness Score	Coordination Score	Recovery Time (days)	*P*-value (95% CI)
Experimental (Beginner)	89%	8.2	8.5	15	<0.01
Experimental (Intermediate)	92%	8.9	9.1	12	<0.01
Experimental (Advanced)	94%	9.4	9.5	10	<0.01
Control (Beginner)	81%	7.0	7.8	25	<0.01
Control (Intermediate)	85%	7.5	8.2	22	<0.01
Control (Advanced)	88%	8.0	8.7	18	<0.01

The research results are significantly reflected in the following aspects:

1) Average Movement Accuracy: The average movement accuracy of intermediate athletes in the experimental group increased significantly to 92%, compared to 85% in the control group ($P < 0.01$).
2) Training Effectiveness Score: The training effectiveness score for intermediate athletes in the experimental group averaged 8.9, higher than the control group's 7.5 ($P < 0.01$).
3) Coordination Score: The coordination score for intermediate athletes in the experimental group was 9.1, significantly better than the control group's 8.2 ($P < 0.01$).
4) Recovery Time: The experimental group that applied AI technology also showed a significantly better change in the incidence of sports injuries before and after training compared to the control group (**Table 2**).

Both the experimental and control groups included 30 athletes, divided by skill levels into beginner (20), intermediate (20), and advanced (20). The study measured variables such as the incidence of sports injuries before and after training, average movement accuracy, and training effectiveness scores. Results indicated that athletes at all skill levels in the experimental group had a significant decrease in the incidence of sports injuries after training and significant improvements in average movement accuracy and training effectiveness scores. In contrast, athletes in the control group experienced an increase in the incidence of sports injuries and no significant improvements in average movement accuracy and training effectiveness scores. This validates the significant effectiveness of AI technology in preventing sports injuries in Southern Lion Dance teaching, while also enhancing overall training quality and performance for athletes.

Table 2. Reduction of sports injuries in Research group equipped with AI technology.

Group	Incidence of Sports Injuries Before Training	Incidence of Sports Injuries After Training	Change in Incidence of Sports Injuries	Average Movement Accuracy	Training Effectiveness Score	*P*-value (95% CI)
Experimental (Beginner)	22%	12%	−10%	89%	8.2	<0.01
Experimental (Intermediate)	18%	6%	−12%	93%	9.0	<0.01
Experimental (Advanced)	14%	5%	−9%	94%	9.4	<0.01
Control (Beginner)	22%	25%	+3%	81%	7.0	<0.01
Control (Intermediate)	18%	20%	+2%	84%	7.8	<0.01
Control (Advanced)	14%	17%	+3%	86%	8.1	<0.01

6. Discussion

The results of this study indicate that Southern Lion Dance athletes trained with AI-assisted methods showed significant improvements in the incidence of sports injuries, movement accuracy, training effectiveness, and recovery time. Specifically, the average movement accuracy of intermediate athletes in the experimental group increased to 92%, demonstrating that the AI technology significantly enhanced their performance quality. Additionally, effect sizes were calculated alongside *p*-values to assess the magnitude of these improvements. For instance, the reduction in sports injury incidence showed a significant difference with a *p*-value of <0.01 and a Cohen's d of 0.75, indicating a large effect size.

6.1. Impact of AI technology on southern lion dance athletes

The application of AI technology in Southern Lion Dance has profound effects on athletes' training and performances. The integration of a detailed Convolutional Neural Network (CNN) model—comprising five convolutional layers with ReLU activation functions and pooling layers—enabled precise movement recognition and posture analysis. This architectural design, including specific hyperparameters such as filter sizes and activation functions, validated the model's rationality and effectiveness.

Firstly, through high-precision data analysis and real-time monitoring, the AI system helped athletes better understand and adjust their movements, thereby reducing the risk of sports injuries. The false alarm rate of the AI model was 7%, and the missed detection rate was 5%, which are acceptable levels for practical applications but highlight areas for further improvement.

Secondly, the personalized training programs provided by the AI technology allowed athletes to optimize their training according to their individual conditions, enhancing training efficiency and effectiveness. The enhancements in training effectiveness and coordination scores were significant ($p < 0.01$, Cohen's $d = 0.68$), suggesting that AI technology not only aids athletes in improving their technical skills but also has a positive impact on their overall performance.

Moreover, the significant reduction in recovery time—12 days for the

experimental group compared to 22 days for the control group—highlights the potential application value of AI technology in injury prevention and rehabilitation. The long-term effects were assessed over a six-month training period, providing insights into the sustainability of the improvements. However, tracking injury rates beyond this period would offer a more comprehensive understanding of long-term benefits.

Finally, the use of AI in psychological training, with real-time feedback and warnings, helped athletes alleviate performance pressure and improve mental stability. The application of AI technology not only enhanced athletes' technical skills and performance quality but also promoted their long-term physical health and career longevity.

6.2. Limitations of the study

Despite the positive effects demonstrated, this study has several limitations. Firstly, the sample size is relatively small, with only 60 athletes, which may affect the statistical power and generalizability of the results. The potential for selection bias exists, as participants may not represent the broader population of Southern Lion Dance athletes. A larger, more diverse sample would strengthen the findings and reduce the impact of any bias.

Secondly, while we provided detailed descriptions of the CNN model, including the number of layers, activation functions, and loss functions, the absence of a model architecture diagram may limit the ability of others to fully validate and replicate the model's rationality. Future studies should include comprehensive diagrams and hyperparameter specifications.

Additionally, the study's duration was limited to six months, and long-term effects beyond this period were not examined. The sustainability of the conclusions remains in question without tracking long-term injury rates over periods like 12 months or more. Longer follow-up studies are necessary to fully assess the lasting impact of AI technology on injury prevention and performance enhancement.

Furthermore, the false alarm rate and missed detection rate of the AI model—7% and 5%, respectively—could affect the practical value of the early warning system. These rates suggest that while the system is effective, there is room for improvement to enhance reliability and athlete trust in the technology.

6.3. Future research directions

Based on the findings and limitations of this study, future research can be advanced in several directions. Firstly, expanding the sample size and including athletes from more regions and diverse backgrounds will help verify the generalizability of the results and reduce selection bias

Secondly, conducting long-term follow-up studies to evaluate the sustainability of the AI technology's impact on athletes' training and injury prevention is essential. Tracking injury rates over extended periods, such as 12 months or more, will provide deeper insights into the long-term benefits and any potential drawbacks.

Thirdly, exploring more advanced AI models and algorithms, including deeper neural networks and reinforcement learning techniques, could further enhance training

effectiveness and the accuracy of sports injury prevention. Incorporating additional technical details, such as model architecture diagrams and hyperparameter settings, will improve the validation and reproducibility of the models used.

Additionally, integrating other emerging technologies like virtual reality (VR) and augmented reality (AR) could offer more immersive and personalized training experiences. Combining AI with wearable technology might also improve real-time monitoring and feedback mechanisms.

Finally, investigating the application of AI technology in other traditional sports and cultural activities could broaden its scope and contribute to the preservation and modernization of cultural heritage. This interdisciplinary approach would support broader sports training initiatives and cultural promotion efforts.

7. Conclusions and recommendations

The results of this study show that Southern Lion Dance athletes trained with AI-assisted methods exhibit significant improvements in the incidence of sports injuries, movement accuracy, training effectiveness, and recovery time. Intermediate athletes in the experimental group achieved an average movement accuracy of 92%, a training effectiveness score of 8.9, a coordination score of 9.1, and a recovery time reduced to 12 days, all significantly better than the control group. These results validate the practicality and effectiveness of AI technology in Southern Lion Dance teaching and training, highlighting its great potential in improving training quality and preventing sports injuries.

Based on the research results, it is recommended that Southern Lion Dance teaching institutions comprehensively introduce AI technology. Through high-precision data analysis and real-time monitoring, training quality and safety can be enhanced. Utilizing AI technology to provide personalized training plans, tailored to the specific conditions of athletes, can improve training outcomes. Combining AI technology with real-time feedback and warning systems can help athletes alleviate performance pressure and enhance mental stability, thereby improving overall performance. Continuously optimizing and refining AI models to enhance their accuracy and robustness in movement recognition and injury prevention, summarizing and promoting the application experiences of AI technology in Southern Lion Dance teaching, and encouraging more sports projects and cultural preservation fields to adopt AI technology to improve overall training levels [19].

Future research can be deepened by expanding sample sizes and research scopes, conducting long-term follow-up studies, exploring more advanced AI technologies, integrating emerging technologies, and broadening application fields. Including Southern Lion Dance athletes from more regions and backgrounds to verify the generalizability of the results, evaluating the long-term effects and sustained impact of AI technology in athletes' training to ensure its sustainable application [20]. Exploring more advanced AI technologies such as deep learning and reinforcement learning to further enhance training effectiveness and the accuracy of sports injury prevention. Combining virtual reality (VR) and augmented reality (AR) technologies to provide more immersive and personalized training experiences for Southern Lion Dance athletes, and investigating the application of AI technology in other traditional

sports and cultural projects to accumulate more experience and support broader sports training and cultural preservation.

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