

Research Progress on the Application of AI Posture Recognition Technology in Traditional Chinese Medicine Exercise Intervention

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Abstract: Traditional Chinese medicine (TCM) traditional exercises serve as an important carrier of the TCM “preventive treatment of disease” system and integrated physical and medical health services. They possess unique advantages in adolescent physical fitness improvement, sub-health regulation, chronic disease prevention and control, as well as rehabilitation medicine. For a long time, traditional Chinese medicine exercises have been plagued by problems such as difficulty in quantifying movement specifications, teaching relying on oral instruction and personal demonstration, lack of real-time feedback in the intervention process, and insufficient personalization, which restrict their modernization, large-scale and standardized popularization, and application. Represented by OpenPose, AI posture recognition technology features non-contact performance, real-time capability, high precision, and low cost, providing key technical support for the digital transformation of traditional Chinese medicine exercises. This paper systematically sorts out the research context and cutting-edge achievements of AI posture recognition in the field of traditional Chinese medicine exercise intervention, summarizes the technical integration paths and application modes, analyzes practical effects, and explores the core bottlenecks, including the transformation of TCM tacit knowledge, algorithm robustness, construction of standard systems, and long-term exercise adherence. It also prospects the future development trend of the integration of AI and traditional Chinese medicine exercises, aiming to provide a theoretical reference and academic basis for subsequent research, technology implementation, and achievement promotion in this field.

Keywords: AI posture recognition; Traditional Chinese medicine exercises; Integration of physical education and medical care; Digital intervention; Movement quantification; Precise health management; Adolescent physical fitness

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1. Introduction

Traditional Chinese medicine culture is a brilliant treasure of Chinese civilization. Typical traditional Chinese medicine exercises include Baduanjin, Wuqinxi, Tai Chi, and Yijinjing. Centering on the core principles of regulating the body, regulating breath, and regulating mind, they integrate physical fitness, emotional

regulation, rehabilitation, and health preservation, as well as cultural inheritance, and are unique non-drug health intervention methods in China. In recent years, with the in-depth implementation of the Healthy China Strategy, the continuous advancement of the 14th Five-Year Plan for the Development of Traditional Chinese Medicine, and the full implementation of policies on the integration of sports with medical care and sports with education, traditional Chinese medicine exercises have gradually entered campuses, communities and families, becoming an important means to address public health problems such as the decline of adolescent physical fitness, high prevalence of sub-health and the younger onset of chronic diseases.

In the process of practical promotion, the limitations of the traditional Chinese medicine exercise intervention model have become increasingly prominent. First, most movement essentials are expressed in empirical and literary descriptions, lacking objective and quantifiable evaluation criteria. Second, teaching relies heavily on manual guidance, making it difficult to ensure movement consistency in large-scale popularization. Third, most intervention plans adopt a one-size-fits-all model with insufficient personalized design for people of different ages and physical constitutions and postural problems. Fourth, there is a lack of real-time supervision and error correction mechanisms during practice; long-term accumulation of incorrect movements may reduce the intervention effect and even cause physical discomfort. Fifth, the effect evaluation mainly relies on subjective perception and observational judgment, which is insufficient in scientificity, objectivity, and persuasiveness. The above problems jointly result in the failure to fully release the health value of traditional Chinese medicine exercises and make it difficult to adapt to the development needs of modern, precise health services.

The rapid development of artificial intelligence and computer vision technology has provided a new way to solve the above dilemmas. Human posture recognition technology can realize quantitative analysis of limb posture and motion trajectory, as well as movement quality, through real-time detection and tracking of key skeletal points. Among them, algorithm models represented by OpenPose, HRNet, and ST-GCN are highly mature and applicable, and have been widely used in motion analysis, rehabilitation assessment, and movement teaching. AI posture recognition boasts the advantages of non-contact collection, real-time feedback, objective quantification, and low deployment cost. It can transform abstract exercise essentials such as keeping the head elevated and relaxed, sinking shoulders and dropping elbows, as well as chest containment and back stretching into computable, monitorable, and evaluable digital indicators. It provides crucial support for the transformation of traditional Chinese medicine exercises from experience-driven mode to data-driven mode, from universal popularization to individual precision intervention, and from result evaluation to process intervention.

At present, interdisciplinary research on AI posture recognition and traditional Chinese medicine exercises has become a cutting-edge topic attracting joint attention in sports science, traditional Chinese medicine, computer science, and preventive medicine. Focusing on the theme of AI posture recognition plus traditional Chinese medicine exercises, this paper comprehensively reviews domestic and foreign research progress in this field, summarizes technical integration paths and application scenarios and core achievements, analyzes existing problems and challenges, and prospects future development directions, so as to provide a systematic reference for academic research and achievement transformation.

2. Theoretical and technical basis for the integration of AI posture recognition and traditional Chinese medicine exercises

2.1. Health value and practical limitations of traditional Chinese medicine exercises

Traditional Chinese medicine exercises are rooted in the holistic concept and the ideology of preventive treatment of disease in TCM. They emphasize the harmony of physique and spirit, the balance of motion and stillness, and internal and external cultivation. Different from modern high-intensity competitive sports, traditional Chinese medicine exercises feature gentle movements, stable rhythm, and high safety, and are suitable for long-term practice by adolescents, middle-aged and older adults, rehabilitation groups, and people with weak physical constitutions. Modern studies have confirmed that traditional exercises such as Baduanjin and Tai Chi can effectively improve cardiopulmonary function, enhance muscle strength and joint flexibility, regulate autonomic nerves, relieve anxiety and depression, and correct abnormal postures. They exert multi-target and comprehensive intervention effects on adolescent myopia, obesity, scoliosis, neck, shoulder, waist, and leg pain, and other common health problems^[1].

The intervention effect of traditional Chinese medicine exercises is highly dependent on movement standardization, while their core essentials are mostly passed down by personal teaching and verbal instruction, making it difficult to convey accurately through written language and set unified standards. In scenarios such as campus promotion, community popularization, and home practice, prominent practical problems, including insufficient professional guidance resources and difficulty in real-time correction of movement deviations, as well as difficulty in quantitative evaluation of intervention effects, restrict the large-scale, standardized, and precise application of traditional Chinese medicine exercises.

2.2. Core advantages and applicability of AI posture recognition technology

Human posture recognition is an important research direction in the field of computer vision. It realizes the quantitative expression of limb posture, motion trajectory, and movement quality by locating and tracking key human skeletal points. The mainstream technical routes are divided into two-dimensional posture estimation and three-dimensional posture estimation. Among them, OpenPose is the most mature two-dimensional posture recognition technology, which can output more than 17 key points in real time, support multi-person recognition and cross-platform deployment, as well as mobile terminal operation. It has the advantages of a small calculation amount, low deployment cost, and strong scene adaptability. Three-dimensional posture recognition can reconstruct three-dimensional spatial posture with the help of depth cameras or multi-view vision, and has higher accuracy in evaluating joint angles and spinal posture as well as body symmetry, which is applicable to professional rehabilitation assessment and laboratory research.

AI posture recognition is highly compatible with traditional Chinese medicine exercises. First, non-contact collection does not change the original exercise form and does not increase physical burden, which is non-invasive and easily accepted by users. Second, it has strong real-time performance and can complete posture evaluation and error correction feedback during exercise in real time. Third, it has outstanding quantification capability and can transform abstract exercise essentials into objective indicators such as joint angle, symmetry, stability, and trajectory smoothness. Fourth, it has low deployment requirements and can be realized with ordinary cameras and intelligent terminals, which makes it easy for large-scale popularization in campuses, communities, and families. Fifth, it can track individual posture changes for a long time to form continuous health files, providing data support for precise intervention and effect evaluation as well as long-term management.

2.3. Core logic of technical integration

The in-depth integration of AI posture recognition and traditional Chinese medicine exercises is essentially the digitalization and objectification, as well as standardization of traditional empirical knowledge. Its core logic lies in capturing human motion information through computer vision, analyzing traditional Chinese medicine movement specifications with data models, improving teaching and intervention efficiency through intelligent feedback, and optimizing intervention schemes with personalized algorithms, so as to finally realize the systematic upgrading of traditional Chinese medicine exercise intervention modes. This integration path not only retains the cultural connotation and health value of traditional Chinese medicine exercises, but also injects the precision and efficiency as well as accessibility of modern technology, which meets the dual requirements of inheritance and innovation of traditional Chinese medicine and the construction of digital health.

3. Research and application progress of AI posture recognition in traditional Chinese medicine exercise intervention

In recent years, extensive explorations have been carried out at home and abroad on the application of AI posture recognition in traditional Chinese medicine exercises. The research covers multiple dimensions, including movement digitization, quantitative evaluation, real-time feedback, personalized prescription, and health intervention, as well as campus popularization. A relatively complete technical system and application system have gradually taken shape, showing an overall development trend from technical verification to scenario implementation, from single function to system integration, and from laboratory research to large-scale application ^[2].

3.1. Research on digitization and standardization of traditional Chinese medicine exercises

Movement standardization is the premise of the large-scale popularization of traditional Chinese medicine exercises. Existing research generally takes posture recognition technology as the core tool to build digital standards. By collecting standard movement data of professional coaches and intangible cultural heritage inheritors, researchers extract key skeletal points, joint angles, motion trajectories, and time sequence features, and transform traditional empirical essentials into computable and reproducible as well as comparable digital models. In the research on mainstream exercises such as Baduanjin, Tai Chi, and Wuqinxi, researchers focus on marking and analyzing the starting form, ending form, and core single movements, and build standard movement databases and typical wrong movement sample databases. Some studies further combine the Delphi method and expert consultation method to determine the movement threshold values and standard ranges for people of different ages and physical constitutions, providing a scientific basis for intelligent evaluation systems. The establishment of digital standards has transformed the traditional teaching mode relying on oral instruction and personal demonstration into a data-based and standardized one, laying a foundation for large-scale popularization ^[3].

3.2. Research on intelligent evaluation and quantitative assessment of movement quality

Movement quality evaluation is the most mature and widely applied direction of AI posture recognition. Based on key point data, existing research constructs comprehensive evaluation models from dimensions

such as static posture, dynamic trajectory, and body symmetry, as well as motion stability, so as to automatically score movement completion and standardization degree. Static evaluation focuses on postural features such as joint angle, trunk verticality, and limb symmetry. Dynamic evaluation analyzes movement fluency and rhythm consistency as well as trajectory smoothness, combined with time sequence information. Comprehensive evaluation integrates multi-dimensional indicators to form a weighted scoring model, which can be applied to teaching assessment, self-monitoring, and competition judgment. A large number of experimental results show that the evaluation results based on AI are highly consistent with professional coaches' scoring, which can effectively replace manual evaluation and improve the objectivity and fairness as well as efficiency of evaluation, providing a new means for the scientific assessment of traditional Chinese medicine exercises.

3.3. Research and application of real-time feedback and intelligent guidance system

Real-time feedback is the key link to improving intervention effects and reducing the occurrence of wrong movements. Existing research generally adopts visual interface, virtual coach, voice prompt, and deviation marking methods to point out wrong parts in real time during exercise and give adjustment suggestions, realizing immersive guidance of correcting movements while practicing. Visual feedback intuitively presents posture deviation by overlaying the standard skeleton and real-time skeleton comparison. Voice guidance uses simple instructions to guide practitioners to adjust their posture quickly. Some studies introduce AR/VR technology to enhance interactive immersion and improve exercise interest and adherence. In scenarios such as campus physical education, home fitness, and rehabilitation training, the real-time feedback system can significantly improve movement standardization, make up for the shortage of professional instructors, and promote the intelligent and personalized upgrading of traditional Chinese medicine exercise teaching.

3.4. Exploration of personalized exercise prescription and dynamic intervention mode

Personalization is the core requirement of precise health management, and it is also an important embodiment of empowering traditional Chinese medicine exercises with AI technology. Based on the quantitative evaluation results of AI posture recognition, researchers have gradually constructed a closed-loop intervention mode of physical portrait–problem identification–prescription generation–effect tracking–dynamic adjustment. The system automatically recommends exercise combinations, training intensity, exercise frequency, and intervention cycle according to practitioners' age, physical posture problems, exercise ability, and practice progress, realizing a precise one-person-one-prescription intervention. Aiming at adolescent typical problems such as scoliosis, round shoulder, and humpback as well as obesity and low physical fitness, personalized prescriptions focus on strengthening core control, spinal stretching, limb symmetry, and whole-body rhythm training, and gradually advance with the improvement of physical conditions, breaking the limitations of the traditional one-size-fits-all intervention mode ^[4].

4. Main problems and challenges in current research

Although remarkable progress has been made in the integration of AI posture recognition and traditional Chinese medicine exercises, there are still in-depth problems and challenges restricting the high-quality development from theoretical construction, technical implementation, and clinical demonstration to large-scale popularization.

First, the digital transformation of traditional Chinese medicine tacit knowledge is insufficient. Traditional Chinese medicine exercises emphasize the integration of mind, breath, and body. Connotations such as breath regulation, mental concentration, force application, and internal Qi circulation are difficult to express through external skeletal point data fully. Existing technologies mostly stay at the quantification level of physical form, and the digital analysis of Qi and spirit is still in the initial exploration stage, failing to fully restore the core mechanism of traditional Chinese medicine exercises^[5].

Second, algorithm robustness and real scene adaptability are limited. In real application scenarios such as complex light, limb occlusion, loose clothing, shooting angle change, and multi-person simultaneous presence, posture recognition accuracy is vulnerable to interference. Adolescents have large physical development differences and variable movement amplitude and rhythm, and the generalization ability and stability of general models still need further improvement.

Third, the industrial standard and evaluation system have not been unified. Different studies adopt different key points, evaluation indicators, threshold ranges, and scoring models, lacking nationally unified technical standards, data standards, and evaluation specifications, resulting in difficulty in horizontal comparison and reuse, as well as large-scale popularization of research achievements.

Fourth, personalized design and long-term adherence need to be further strengthened. Most systems focus on error correction and guidance, lacking gamification, incentive mechanisms, social interaction, and growth system design to improve adherence, making it difficult to maintain adolescents' long-term exercise interest. Adaptive dynamic prescription algorithms are still relatively simple, and it is still difficult to realize accurate iteration of personalized prescriptions for different individuals.

5. Future development trends and research prospects

Facing the strategies of Healthy China, Digital China, and the inheritance and innovation of traditional Chinese medicine, the integration of AI posture recognition and traditional Chinese medicine exercises will continue to develop towards greater intelligence, standardization, universality, clinical relevance, and cultural connotation. The following research directions are worthy of attention in the future.

First, promote the in-depth integration of the TCM mechanism and multi-modal data. Break the limitation of simple external posture recognition, integrate breathing, heart rate, infrared thermal imaging, electromyography, and TCM syndrome information, and build an integrated evaluation model of physique-breath-spirit, which is closer to the essence of TCM health preservation and improves the theoretical depth and clinical persuasiveness.

Second, construct a unified standard system and shared data sets. Accelerate the formulation of industrial standards for AI recognition and quantitative evaluation, as well as movement specifications and data interfaces of traditional Chinese medicine exercises, and establish publicly shared high-quality labeled data sets to promote the standardization and replicable popularization of technological achievements.

Third, develop lightweight and highly robust edge algorithms. Optimize the deployment efficiency of mobile terminals, improve the adaptability in complex scenarios, realize instant use on mobile phones, tablets, and smart TVs, reduce the popularization threshold, and achieve full coverage in campuses and families.

Fourth, strengthen personalized and gamified interactive design. Combine the behavioral characteristics

of adolescents, integrate the task system, point incentive, virtual image, and social interaction elements to improve long-term adherence. Build an adaptive dynamic prescription engine based on big data and large models to realize full-cycle, precise intervention.

6. Conclusion

AI posture recognition technology provides key support for the modernization, standardization, and precision of traditional Chinese medicine exercises. It has made important progress in movement digitization, quantitative evaluation, real-time feedback, personalized prescription, adolescent health promotion, and rehabilitation medical treatment. It effectively solves the core bottlenecks of inconsistent standards, insufficient personalization, delayed feedback, and difficult effect evaluation in traditional intervention modes, providing a feasible path for the inheritance and innovation of traditional Chinese medicine and the construction of digital health. At present, this field is developing from technical exploration to application implementation, from single posture recognition to multi-modal integration, and from manual guidance to intelligent closed-loop intervention, showing great health value, educational value, social value, and cultural value. At the same time, the development of this field still faces practical challenges such as the transformation of TCM tacit knowledge, algorithm robustness, standard system construction, and exercise adherence, as well as empirical evidence. In the future, it is necessary to strengthen interdisciplinary integration, technical optimization, and standard construction as well as empirical research, so as to promote the in-depth integration of AI and traditional Chinese medicine exercises, and make it an important force serving adolescent physical health, national health promotion, and inheritance and innovation of traditional Chinese medicine, and provide Chinese solutions for global health governance.

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Disclosure statement

The authors declare no conflict of interest.

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