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Integrating Traditional Chinese Medicine massage therapy with machine learning: A new trend in future healthcare

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Highlights

- Machine learning can enhance the individualization of treatment in Chinese massage.
- An intelligent system improves the efficiency of Traditional Chinese Medicine massage therapy.
- The integration of Traditional Chinese Medicine Massage Therapy with machine learning represents a new trend in future healthcare.

Abstract

The growing demand for healthcare has brought Traditional Chinese Medicine (TCM) massage therapy into the spotlight in academic circles. Numerous studies have underscored the effectiveness of TCM massage in health promotion, disease amelioration, and quality of life enhancement. However, the field faces challenges such as inconsistent training and inadequate transfer of experiential knowledge. Recently, machine learning has shown potential in the medical field and its application in TCM massage therapy offers new developmental opportunities. This paper reviews key research areas exploring the synergy between machine learning and Chinese massage therapy, including acupoint localization and identification, massage practice, and personalized treatment plans. It summarizes progress and identifies the challenges in integrating these technologies. Despite potential risks, merging these technologies is poised to be a trend in future healthcare, driven by advances in computer technology and the needs of TCM practitioners.

Keywords: Traditional Chinese medicine, machine learning, massage therapy

Introduction

With the increasing demand for healthcare services, Traditional Chinese Medicine (TCM) massage therapy is receiving heightened attention and recognition within academia. Research and clinical practices have confirmed the significant benefits of TCM massage in health improvement, illness treatment, and life quality enhancement [1-3]. These endeavors have established a robust scientific foundation and provided insights into the therapeutic mechanisms of TCM massage therapy. Despite these advances, the field still grapples with issues such as inadequate knowledge transfer, inconsistent training standards, and unclear criteria for therapeutic outcomes, which impede further development and adoption [4-6]. Additionally, the high doctor-patient ratio increases the workload of practitioners. Addressing these challenges through modern engineering technology could revolutionize TCM massage techniques, making them more scientific and standardized. This approach would enhance the effectiveness of

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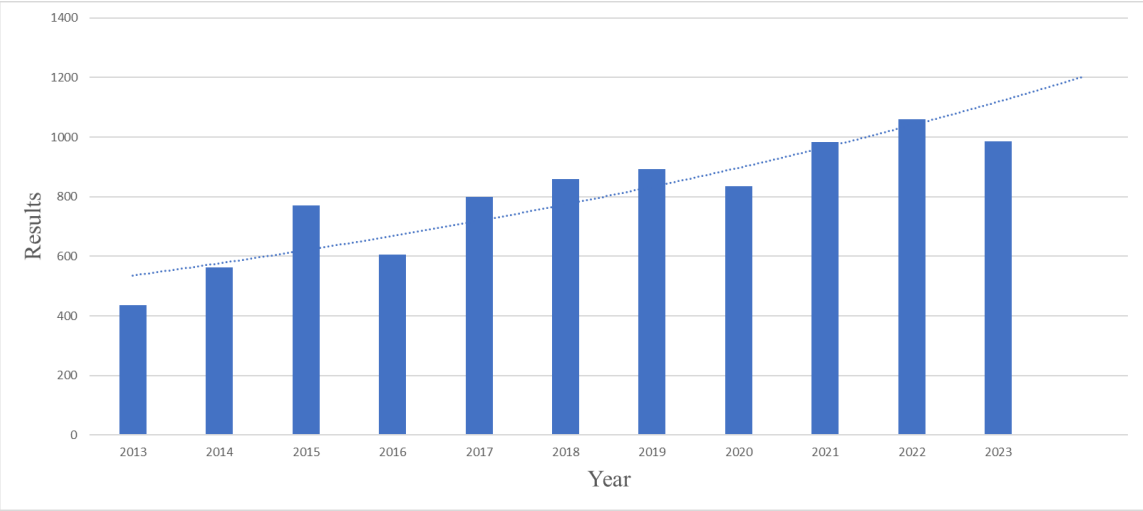

Figure 1. Number of published paper entries in the last ten years.

massage therapy and facilitate the delivery of superior healthcare services.

In recent years, the evolution of computer technology, particularly in artificial intelligence with a focus on machine learning, has become a prominent subject within engineering and technology disciplines [7]. Machine learning involves computer systems that learn by analyzing and recognizing patterns in datasets, enabling predictions, decisions, or task executions based on this data. Characterized by automation, generalization, iterative optimization, data-centricity, and adaptability, machine learning is rapidly expanding across various sectors [1, 2, 8, 9].

In healthcare, machine learning is increasingly used for image recognition, recommendation systems, and medical diagnostics, enhancing the development of intelligent technologies. Notably, the application of machine learning in TCM has gained momentum in academia, with significant publications emerging. For example, Xu et al. developed a dynamic treatment strategy for rectal cancer using a survival cost-sensitive classification learning algorithm, which demonstrated clinical effectiveness [10]. Chen et al. utilized a Convolutional Neural Network (CNN) for symptomatic text classification in TCM, achieving accurate symptom categorization [11]. Moreover, Yang et al. introduced the "Zhongjing" large language model tailored for Chinese medicine, refined through expert feedback, marking a significant advancement in language model applications within the field [12].

The potential for integrating machine learning with Chinese massage therapy (Tui-na) is further highlighted by the increasing number of academic publications over the past decade, as illustrated in **Figure 1**, derived from Google Scholar searches using keywords "Chinese massage therapy", "machine learning", and "Chinese Tui-na".

Despite the growing evidence supporting the efficacy of machine learning in TCM massage therapy, a comprehensive review of this integration is still lacking. This study aims to critically evaluate the risks and benefits by analyzing existing literature, which will not only inform clinical decisions but also inspire further research.

Application of machine learning in Chinese massage therapy practice

TCM massage, a cornerstone of Chinese medicine, plays an essential role in regulating meridians, qi, and blood circulation, aiming to prevent and treat diseases, promote health, and restore bodily balance [13]. It employs a theoretical framework that includes concepts of qi, blood, meridian systems, and meridian points. Following evidence-based TCM principles, massage techniques are tailored to the individual symptoms and physical characteristics of patients. TCM massage is proven effective in clinical settings for treating a range of conditions such as musculoskeletal pain, neurological disorders, respiratory issues, and circulatory disorders [14-16].

The advent of machine learning has marked significant advancements in traditional Chinese massage therapy, enhancing the integration of engineering technology with alternative massage systems. Currently, the application of machine learning for quantitative and objective assessments of massage therapy outcomes is expanding. Scholars globally focus on three primary areas where machine learning intersects

with Chinese massage therapy:

• Automated acupoint localization and identification: Machine learning is applied to automate the identification and localization of human acupoints through image processing and pattern recognition. Advances in deep learning algorithms, utilizing extensive acupoint datasets for model training, have significantly improved the precision and efficiency of acupoint positioning, enhancing the practice of TCM massage.

• Intelligent massage assistance system: Integrating machine learning with intelligent sensing technologies, this advanced system provides real-time monitoring and guidance for TCM massage. Analyzing the effects of massage therapy and patient feedback, the system supports data-driven decisions, aiding practitioners in their therapeutic approaches.

• Personalized massage treatment plan: Machine learning facilitates the creation of customized treatment plans by integrating individual health data and physiological parameters. This system adapts massage techniques and procedures to the patient's specific conditions and feedback, enabling dynamic adjustments for more accurate and effective treatments.

Application of machine learning to automated acupoint localization and identification

Acupoints are integral to Chinese medicine, facilitating the flow of qi and blood, alleviating pain, and regulating internal organs, thus playing a vital role in maintaining physical health [17, 18]. Accurate identification and application of acupoints are critical in massage therapy. Traditionally, locating acupoints has relied on the experience and expertise of practitioners, a process that can be subjective and time-consuming [19]. In contrast, automated acupoint localization and recognition using machine learning presents an effective solution to overcome these limitations.

A common strategy involves the use of vision devices for image recognition, where machine learning techniques, particularly deep learning algorithms like CNN, are applied to automatically recognize acupoint images. This automation enhances the accuracy and efficiency of acupoint localization. Research has shown that leveraging bony joint feature points significantly improves acupoint localization [20, 21]. Some studies use neural networks to capture human joint data and apply proportional geometric measurements to understand acupoint geometric relationships, combining this with three-dimensional information for precise acupoint positioning. These methods have achieved an average localization accuracy of 2.36 cm and real-time performance of up to 14 frames per second, demonstrating adaptability across various body types, environments, and postures [22].

Further increasing accuracy, Wang et al. employed an Artificial Neural Network for more refined acupoint identification. Their approach includes image preprocessing to segment the region of interest on the sole, mapping the Foot Acupoint Profile to the foot image to accurately locate reference massage points [23]. Additionally, Zhang et al. developed an integrated deep confidence network that merges manually labeled and rule-matched data, reducing manual effort in acupoint localization and enhancing model accuracy [24].

There are also advancements in acupoint visualization techniques. Zheng et al. explored an Augmented Reality overlay method for facial virtual acupoints, where real-time computed facial acupoint coordinates are superimposed onto the actual scene, providing physicians with an intuitive means of locating acupoints [25].

Ongoing research continues to explore new methods utilizing machine learning in acupoint localization. One study applied temperature specificity detection and edge detection algorithms to automatically pinpoint major chest organs and localize acupoints based on the physiological structures of the chest and upper limbs, achieving a localization accuracy over 90.12% [26]. Another innovative approach involves the fusion of RGB and depth images in a deep CNN to create a novel 3D acupoint localization method, as outlined in **Table 1** [27].

Application of machine learning to intelligent massage assistance systems

Intelligent massage assistance systems combine artificial intelligence technologies with traditional massage expertise to analyze data, recognize and classify massage techniques, conduct personalized health data analyses, and provide real-time monitoring and feedback. These systems employ machine learning, deep learning, and sensor technology to enhance the accuracy, personalization, and efficiency of traditional massage practices [28, 29]. They assist practitioners in selecting appropriate techniques, adjusting treatment plans, and delivering more scientifically informed and efficient therapy, thus contributing to the preser-

Table 1. Comparative analysis of techniques related to acupoint localization in traditional Chinese medicine massage

Localization approach	Machine learning models	Advantages	Weaknesses
Traditional machine learning [26, 27]	BP neural networks	Robustness	Gradient vanishing problem, Overfitting problem
Deep learning [20]	Convolutional Neural Network	Strong generalization ability	Data quality limitations
Machine learning based on temperature specificity [24]	Support Vector Machine	Leverage individual physiological features	Data acquisition complexity
Deep learning based on RGB recognition [25]	Convolutional Neural Network	3D localization	Data quality limitations

Note: BP, Backpropagation; RGB, red-green-blue.

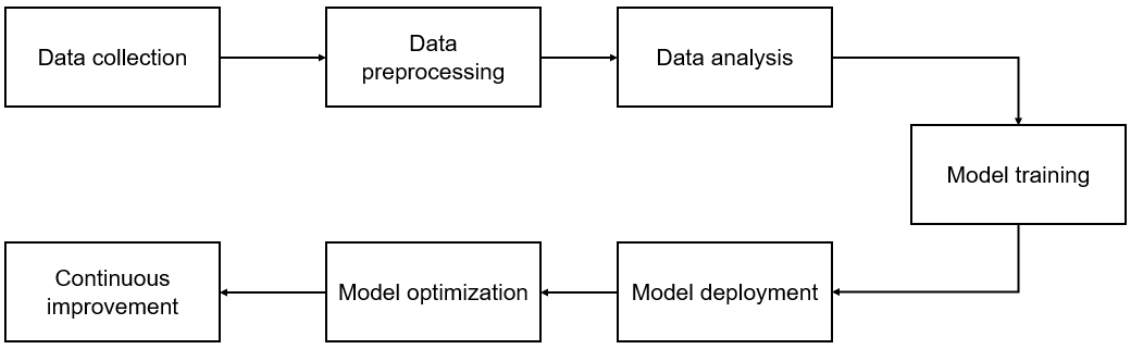

Figure 2. General framework for creating an intelligent massage assistance system.

vation and advancement of traditional Chinese massage technology [30].

A crucial component in developing these systems is the precise acquisition of massage techniques. Zhu et al. developed a manipulation acquisition system using tactile sensors, employing CNNs, long short-term memory networks, and attention mechanisms to identify massage techniques with a 100% classification accuracy [31]. This system deviates from traditional methods that focus only on force distribution across different hand regions of a practitioner. Instead, it utilizes a triaxial force sensor to detect the magnitude and direction of spatial forces, crucial for quantifying forces in TCM physiotherapy practices like massage. Support Vector Regression is then applied to translate strain signals into force components, allowing for the continuous recognition of varied force magnitudes and directions [32].

Beyond mechanical data analysis, Jia et al. explored capturing real-time image feature data of patients' joints and gestures during autonomous massage sessions [33]. They used a CNN to calculate human postures, providing real-time cues for autonomous massage and improving the accuracy of massage procedures.

The overarching goal in developing intelligent massage assistance systems is to quantify and evaluate TCM massage techniques. Li et al. created a learning framework that combines deep learning with variable impedance control technology [34]. This framework determines the necessary impedance gain and angle for each joint of a massage robot, enabling autonomous decision-making during massage operations [32]. Additionally, these systems often utilize various physiological signals. For example, Long et al. developed muscle fatigue state classifiers using surface Electromyography signals to assess massage effects, and Zheng et al. used the circular Hough transform for iris segmentation from periocular images, evaluating the effectiveness of periocular massage [35, 36].

These advancements illustrate a shared process in developing intelligent massage assistance systems that leverage machine learning technologies, as depicted in **Figure 2**.

Application of machine learning to personalized massage treatment plans

TCM Personalized Massage Therapy tailors treatments based on TCM theories and individual requirements, emphasizing the creation of customized regimens. These plans consider the patient's constitution, condition, symptoms, and specific needs, incorporating TCM meridian

Table 2. The currently accessible LLMs for TCM

Name	Release Time	Service Area	Supported Languages	Data Entry
MedChatZH [42]	2024	Medical guidance	Chinese, English	764,000
HuaTuo [43]	2023	Comprehensive Diagnosis	English	
Qibo [44]	2024	Corpus	English	
TCM-GPT [45]	2023	Comprehensive Diagnosis	English	7 billion
Zhongjing [12]	2024	Medical guidance	English	70,000

Note: LLMs, large language models; TCM, traditional Chinese medicine; GPT, generative pre-trained transformer.

theory and diagnostic techniques such as observation, olfaction, inquiry, and pulse diagnosis [37].

Although research in this area is still emerging, several scholars have applied machine learning algorithms to personalize recommendations for comprehensive treatment plans that include massage and acupuncture. For instance, Sun et al. utilized Support Vector Machine algorithms to select clinical acupoints for treating functional constipation, with comparative experiments showing a total effective rate of 96.56% in the experimental group, significantly higher than the control group's 75.02% [38]. Chae et al. explored artificial intelligence methods to quantify the target disease for each acupoint, aiming to improve the specificity of acupoint indications [39].

Additionally, Large Language Models (LLMs) are increasingly recognized as a valuable tool in this domain. LLMs, which use deep learning to generate coherent natural language texts, are particularly useful for providing insights and recommendations on TCM diagnosis, treatment strategies, medication, and disease prevention [40]. However, there are currently no LLMs specifically designed for TCM massage therapy, indicating a gap in the application of this technology. This paper highlights the need for such models and provides an overview of existing LLMs in TCM, as summarized in **Table 2** [41].

Key challenges in integrating machine learning with TCM massage and innovative solutions

Key challenges

Data access and labeling issues

TCM massage encompasses a wealth of clinical experience and theories, representing a vast pool of unstructured knowledge passed down through teaching and practice. This knowledge, which includes a diverse range of manual techniques, diagnostic methods, and treatment concepts, often lacks the structured data format crucial for analysis by machine learning algorithms. The primary challenge lies in effectively using existing data to refine labels for machine learning applications. Labeling in machine learning refers to the assignment of correct labels or categories to data for training and testing algorithmic models, a critical process in supervised learning where models rely on existing labels to make predictions and classifications. The task of efficiently gathering, organizing, and annotating massage movement data to create suitable datasets for machine learning applications requires the integration of expert knowledge, modern technology, and advanced data processing methods. Addressing this challenge is essential for integrating TCM massage principles with machine learning, propelling the scientific and modern evolution of TCM massage practices.

Model training and optimization issues

The diversity and variability inherent in TCM massage contribute to differences in techniques among patients, conditions, and practitioners. Constructing a model capable of accommodating such diversity is a significant challenge. The model must account for individual variances and unique circumstances to ensure the efficacy and safety of the therapy. Numerous studies have focused on developing a versatile and adaptable massage model through continuous exploration and optimization efforts.

Clinical validation and credibility issues

Implementing machine learning techniques in TCM massage necessitates clinical validation to verify the therapeutic efficacy and safety of the interventions. Clinical validation assesses the model's performance in real-world settings, testing its adaptability and effectiveness across different scenarios. Additionally, verifying the model's credibility is crucial to ensure the accuracy and reliability of the results produced by the machine learning algorithm. Through rigorous clinical validation and credibility verification processes, the effectiveness and safety of massage therapy can be guaranteed, advancing the sustainable development and application of machine learning technology within the realm

of TCM massage.

Innovative solutions

Standardized TCM massage techniques

To create a standardized dataset for TCM massage, expert knowledge and practitioner experience have been extensively utilized. Numerous studies aim to catalog massage actions, detailing techniques, intensity, and targeted areas [46, 47]. Advanced technologies such as deep learning and computer vision are employed to process images and videos of massage movements, extracting key features and annotating the data accordingly. Additionally, natural language processing is applied to analyze TCM massage-related literature semantically, further refining and enhancing data annotation [31, 33]. Integrating these technologies facilitates the systematization and standardization of TCM massage knowledge, laying a solid foundation for incorporating machine learning within the field.

Selection of highly adaptive models

The integration of deep learning has emerged as a prominent academic solution, enabling the design of complex neural network structures and extensive data training to meet diverse massage needs. Transfer learning techniques are also employed, allowing knowledge transfer from one domain to another to enhance model generalization and adaptability. Furthermore, reinforcement learning is used to allow the model to continuously optimize its strategies through interaction with the environment, thus adapting to varying massage requirements [24]. By leveraging these advanced methodologies, a more intelligent and adaptive massage model can be developed, enhancing the potential for advancement and application in TCM massage practices.

Building cooperation mechanisms

A collaborative mechanism is proposed to integrate machine learning technology with clinical practice, aligning with the health promotion principles of the Healthy China Policy [48]. This involves creating evidence-based experimental protocols and evaluation criteria to validate the effectiveness and safety of combining TCM massage with machine learning models [49]. This collaborative approach aims to modernize TCM massage, elevate therapy standards, and support the overarching goal of promoting health and well-being.

Conclusion and outlook

Reflecting on the research findings and current literature, integrating TCM massage with machine learning technology holds significant potential and promises notable advancements. Machine learning introduces novel perspectives and methods to TCM massage therapy, enabling personalized treatment, efficient diagnosis, and optimization of treatment strategies. This technology facilitates the analysis and collection of clinical data for practitioners, identifies individual treatment factors, and automates the generation of treatment plans. Personalized treatment, a highlight of machine learning, involves constructing models that predict patient conditions and recommend tailored treatment plans, thereby enhancing the relevance and effectiveness of therapies. Additionally, the digitization of traditional medicine represents a significant shift for TCM, where databases created for machine learning become valuable training and benchmark data, supporting the inheritance and innovation of TCM Tuina techniques.

However, the integration of machine learning with TCM massage is not without risks. One major concern is the potential for model misdiagnosis. Machine learning models, which make predictions based on training data, may not be perfectly adapted to every individual, leading to incorrect diagnostic and treatment decisions that could impact patient health. Additionally, TCM practitioners require further training and technical support to collaborate effectively with engineers in dataset construction. Social acceptance is another crucial factor, especially for new health-related technologies, which often face public skepticism and distrust initially; thus, increasing public acceptance of machine learning technologies is essential.

In conclusion, integrating TCM massage with machine learning involves various risks and challenges that necessitate a comprehensive consideration of technology, law, and ethics. It requires gradual development and careful application to achieve optimal clinical outcomes while ensuring patient safety and therapeutic efficacy. Enhanced collaboration between academic institutions and healthcare facilities is vital to advance the application of machine learning in TCM massage, continuously improving the quality and efficacy of therapy.

Looking ahead, as machine learning technology further advances in the medical field, the integration of TCM massage and machine learning is expected to deepen and become

more refined. Through collaborative efforts, more comprehensive datasets and models can be developed to better support and guide TCM massage therapy. This collaborative approach will also promote in-depth research and preservation of TCM massage techniques, cultivate a new generation of professionals skilled in both medical practices and machine learning, and inject new vitality into the evolution of massage therapy. Ultimately, this integration aims to enhance the widespread adoption of TCM massage in healthcare, offering safer and more effective treatment options to a broader patient base and benefiting the community as a whole.

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