THE IMPLEMENTATION PATH OF PERSONALIZED FITNESS FOR RURAL ELDERLY EMPOWERED BY INTELLIGENT EXERCISE PRESCRIPTION

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Abstract: This study responds to the call to accelerate the digital transformation in rural areas, and pays special attention to promoting the active and healthy aging of rural elderly. We used generative artificial intelligence (AI) technology to develop and evaluate personalized exercise prescriptions, and planned a digital and inclusive path for rural fitness projects. This study adopts a mixed design method, which combines controlled field experiments, systematic literature review and semi-structured expert interviews. Firstly, a theoretical framework based on evidence is established by synthesizing domestic and foreign literatures. Secondly, experts in the fields of rural public health, sports science and digital health were interviewed to improve the intervention program. Finally, a number of field experiments were carried out in rural communities. Baseline health data were collected from older people living in the community. Then, the generative AI algorithm generates a personalized exercise prescription, which details the exercise mode, intensity, duration, frequency and progress. Participants followed the plan of AI generation and performed 12 weeks of exercise under the supervision and guidance of coaches.
Keyword: Exercise prescription; Generative AI; Rural elderly; Personalized fitness; Rural revitalization

1 INTRODUCTION

Rural populations are ageing rapidly, yet older adults in these settings remain among the least physically active and most underserved by evidence-based exercise services. National policy documents issued in early 2025 identify the digital transformation of rural areas and the promotion of "Healthy Ageing" as strategic priorities, explicitly calling for upgraded information infrastructure and inclusive, technology-enabled public-health solutions. Parallel national fitness and "sports-power" strategies recognize that rural fitness facilities and professional guidance are scarce, while residents' health awareness and scientific exercise knowledge are limited. Against this backdrop, the present study explores whether generative artificial intelligence can provide a personalised, low-cost, and scalable remedy.Field interviews and baseline surveys conducted in rural Shaanxi reveal three dominant barriers: (1) weak exercise awareness—many older adults equate farm labour with adequate physical activity; (2) homogeneous, unplanned exercise modalities such as walking or housework; and (3) a severe shortage of qualified instructors able to deliver safe, individualised programmes. These factors collectively restrict health improvements and increase injury risk.To address these gaps, we developed an open-source, voice-interactive AI device ("Little Teacher") that automatically generates exercise prescriptions from simple health inputs. A three-month, two-arm randomised controlled trial involving 40 community-dwelling older adults (20 per arm) was implemented to evaluate feasibility and preliminary efficacy. Primary outcomes included functional capacity, balance (via lower-limb surface electromyography during single-leg stance and gait tasks), blood pressure, and self-reported exercise adherence. Secondary outcomes focused on user acceptability and social engagement.By integrating policy guidance, user-centred design, and rigorous field evaluation, this study offers the first empirical evidence on the potential of generative AI to deliver personalised, inclusive fitness services in resource-constrained rural settings.

2 RESEARCH OBJECTIVE

2.1 Policy Background

With the rapid development of China's economy and society, rural revitalization has become an important strategic task in the new era. In January 2025, China has issued the "Comprehensive Rural Revitalization Plan (2024-2027)", which pointed out the direction for rural development. Among them, Article 26 explicitly proposes to accelerate the construction of digital rural areas, improve information infrastructure, implement smart radio and television rural projects, promote the digital and intelligent upgrading of infrastructure, and build a comprehensive information service system[1]. This strategic initiative aims to empower rural development through digital technology, enhance the level of rural public services, and improve the quality of life of rural residents.

2.1.1 Digital transformation

In terms of digital transformation, the "Overall Layout Plan for the Construction of Digital China" proposes to cultivate and strengthen the core industries of the digital economy, and stimulate the innovation vitality of the digital economy. In addition, the "Key Points for the Development of Digital Economy in 2025" clarify seven key tasks[2], covering accelerating the release of data element value, improving data infrastructure systems, optimizing the layout of computing resources, etc., demonstrating China's forward-looking layout of accelerating the construction of a digital power.

2.1.2 Implementation of national fitness strategy and sports power strategy policies

In terms of implementing the national fitness strategy and the strategy of building a strong sports nation，on the one hand, rural fitness facilities still cannot meet the fitness guidance needs of rural people, and there is a serious shortage of professional fitness guidance personnel, which makes it difficult for rural residents to obtain scientific and systematic fitness guidance; On the other hand, rural residents have relatively weak health awareness and fitness concepts, lacking understanding of scientific fitness and preventive health concepts. In this context, this article aims to explore the path of rural fitness towards digitalization and inclusiveness by promoting artificial intelligence (AI) technology and utilizing AI bots. By leveraging the powerful data processing and intelligent analysis capabilities of AI technology, personalized and convenient fitness guidance services are provided to rural residents, promoting the popularization and improvement of rural fitness services.

2.1.3 Comprehensive rural revitalization plan becomes an important strategic task

The comprehensive rural revitalization plan has become an important strategic task. In the process of comprehensive rural revitalization, the health issues of rural residents are increasingly receiving attention. Health is the foundation of rural revitalization[3], however, poverty caused by illness and returning to poverty due to illness are still key issues that urgently need to be addressed. At present, fitness services and health management in rural areas are facing many challenges, and effective solutions are urgently needed to promote the health and well-being of rural residents.

2.2 Background of Requirements

2.2.1 Health needs

Against the backdrop of an increasingly significant trend of population aging, the proportion of elderly population in rural areas is showing a continuous upward trend, and the health issues of elderly people in rural areas have evolved into a widely concerned topic in society. The health status of elderly people in rural areas is not only directly related to their personal quality of life, but also has a profound and direct impact on the economic situation of rural families and the stable development of society. According to relevant statistical data, the health problems of the elderly population in rural areas have to some extent exacerbated the economic burden on families and affected social harmony and stability. However, as of now, the existing medical facilities and service levels are unable to meet the growing personalized health needs of the elderly[4]. At the same time, the coverage of health management services has significant limitations, making it difficult to comprehensively and deeply benefit every elderly person.

2.2.2 Fitness guidance requirements

With the development of society and the improvement of people's health awareness, the demand for health among rural elderly is increasing day by day. However, due to the lack of systematic scientific fitness knowledge and professional guidance personnel, it is often difficult to take practical and effective fitness measures to improve their physical function. Although elderly people in rural areas yearn for personalized fitness programs to meet their aspirations and pursuits for a healthy lifestyle, they face many difficulties in reality. On the one hand, many social instructors lack enthusiasm and initiative in carrying out fitness guidance work in rural areas due to various factors such as work environment, salary and benefits, and transportation convenience, resulting in a serious shortage of rural fitness guidance forces. On the other hand, the lack of guidance resources for rural fitness makes it difficult for the elderly to have a scientific and directional approach during the fitness process, making it difficult to effectively guarantee fitness results. In addition, the supply-demand contradiction of fitness resources is gradually becoming prominent, and many elderly people in rural areas find it difficult to enjoy high-quality fitness guidance services[5].

2.2.3 Personalized needs

With the gradual improvement of people's living standards and the continuous transformation of health concepts, the fitness needs of rural elderly have gradually shifted from simple physical activities to a more personalized and precise direction. However, there are obvious shortcomings in the current rural fitness service market in meeting the personalized fitness needs of the elderly, mainly reflected in the following aspects: firstly, the homogenization of fitness facilities and services is quite serious, making it difficult to meet the differentiated needs of different types of elderly groups; Secondly, fitness instructors lack a deep understanding and comprehensive consideration of individual physical conditions, interests, and hobbies of the elderly.When formulating fitness plans, they often adopt a "one size fits all" approach, resulting in poor fitness results and even potential harm to the elderly's bodies.

2.3 Application Value

2.3.1 Health benefits

Generative artificial intelligence exercise prescriptions provide scientific and personalized fitness programs for rural elderly people, effectively improving their overall health status by preventing chronic diseases, improving physical

fitness, and enhancing immunity. This not only improves the quality of life for the elderly[6], but also reduces the medical burden on families and society, promoting harmony and stability in rural society[7].

2.3.2 Optimization of fitness services

Effectively solving the problem of a shortage of professional fitness instructors in rural areas, providing convenient and efficient fitness guidance services for the elderly. By generating personalized exercise prescriptions, it meets the fitness needs of different elderly people and improves fitness effectiveness. At the same time, the combination of online and offline models has made fitness services more popular, enhancing the enthusiasm and participation of the elderly in fitness.

2.3.3 Enhancement of rural community vitality

Promoting generative artificial intelligence exercise prescriptions and encouraging more elderly people in rural areas to participate in fitness activities has enhanced their social interaction and sense of community belonging. The popularization of fitness activities has promoted the cohesion and vitality of rural communities, enriched the spiritual and cultural life of the elderly, and helped to build a more harmonious and active rural community environment.

2.3.4 Promoting rural development

The promotion and application of generative artificial intelligence exercise prescriptions have promoted the development of fitness in rural areas and become an important component of comprehensive rural revitalization. It not only focuses on the health needs of the elderly, but also lays a solid foundation for sustainable development in rural areas by improving their quality of life and happiness. In addition, the application of this technology may also drive the development of related industries, such as fitness equipment manufacturing, health management services, etc., injecting new vitality into the rural economy[8].

3 RESEARCH METHOD

3.1 Expert Interview Method

Invite experts in rural fitness, artificial intelligence technology, geriatrics, sports science and other related fields to conduct interviews.

3.2 Experimental Method

3.2.1 Experimental design

This study adopts a randomized controlled experimental design to evaluate the application effect of generative artificial intelligence (AI) exercise prescription in rural elderly fitness using a scientifically rigorous method. The experimental site was selected in Huxian County, Xi'an City, Shaanxi Province. A total of 40 healthy rural elderly people without major exercise contraindications were recruited as research subjects and randomly divided into an experimental group and a control group, with 20 people in each group. The elderly in the experimental group received generative AI exercise prescription guidance, while the control group received traditional fitness guidance services. The experimental period is set at three months to ensure that the long-term effects of exercise prescription on the physical function of elderly people can be fully observed.

3.2.2 Data collection

Before, during (every two weeks), and after the experiment, comprehensive health data was collected from two groups of elderly people to dynamically monitor changes in their physical functions. The collected physical function indicators include: height and weight; Blood pressure and heart rate; Balance ability; Exercise habits include weekly exercise duration, frequency, and type of exercise. Considering that the main health risk faced by the elderly is the risk of imbalance caused by decreased balance ability, we focused on collecting lower limb electromyography data from 40 rural elderly people. Using a surface electromyography meter, electrodes are placed on the four key muscle areas of the elderly, namely the quadriceps, tibialis anterior, gluteus maximus, and gastrocnemius, to perform authoritative balance tests such as single leg standing, eye closed single leg standing, and vestibular gait. The electrical signal activity of the muscles is recorded to reflect their activation and coordination, providing objective basis for evaluating balance and motor control abilities. Conduct experimental data analysis and comparison to draw conclusions.

3.3 Literature Review Method

3.3.1 Literature collection

Collect literature on rural elderly fitness, generative artificial intelligence, exercise prescriptions, and other related fields through domestic and foreign academic databases such as CNKI, Wanfang Data, PubMed, Web of Science, etc. Focus on recent research achievements to ensure the cutting-edge and scientific nature of the research[9].

(1) The current situation and problems of fitness among elderly people in rural areas

Rural elderly people have a high enthusiasm for participating in sports activities, but their cognitive level is limited. Most people believe that daily labor can replace physical exercise, and their understanding of the difference between sports activities and daily physical activities is insufficient. The construction of fitness service system for rural elderly faces many challenges, including a shortage of professional and technical talents, ineffective policy implementation, uneven resource allocation, outdated infrastructure, single sports activity content, and low participation rate. In addition, most elderly people in rural areas suffer from chronic diseases and require more health attention and assistance[10].

(2) Policy background and strategic significance

The "Healthy China 2030" Plan Outline proposes to comprehensively improve the health level of the people, clearly promote sports activities for key populations, and the health status of rural elderly people as a special group is of great significance for achieving the Healthy China strategy. The rural revitalization strategy emphasizes the importance of farmers, and middle-aged and elderly people in rural areas are the main force in agricultural and rural development, as well as the key group to cope with population aging and promote healthy aging development[4].

(3) Technology and Mode Innovation

The construction of "FIT SCRIPT" proves the necessity of introducing artificial intelligence in the formulation of exercise prescriptions. Its research and development provide a new approach for the field of exercise prescription research, breaking traditional thinking patterns, enhancing system capabilities, and expanding application scope The public health services of the "integration of sports and medicine" model in the community can not only improve the health level of residents, improve their lifestyle, reduce medical expenses, but also have a profound impact on deepening the development of national health. The application prospects of artificial intelligence in the field of national fitness are broad, and the integration of artificial intelligence into exercise prescriptions is of great significance in promoting the high-quality development of national fitness[11].

(4) Development process and optimization path

The intelligent exercise prescription has gone through the initial stage of development, the rising stage of development, and the comprehensive development stage. In its development process, policies and regulations provide the basic basis, interdisciplinary studies provide innovation drive, and healthy upgrading provides endogenous motivation.

The promotion of national fitness development through intelligent exercise prescriptions faces practical challenges such as slow policy and regulatory follow-up, insufficient independent technological innovation, and a disconnect between market mechanisms and user needs The optimization path includes refining and improving policies and regulations, and leveraging institutional support and guidance; Vigorously developing intelligent technology and strengthening the driving role of technological innovation; Focus on user needs and activate market regulation.

4 RESEARCH CONTENT

4.1 Analysis of the Fitness Status and Problems of the Elderly Population in Rural Areas

This study conducted an in-depth investigation of the fitness status of elderly people in rural areas using interview methods, and conducted a detailed analysis from multiple dimensions such as health status, exercise habits, fitness awareness, and behavior. Research has found that there are many urgent problems that need to be solved in terms of fitness among the elderly population in rural areas. Firstly, the awareness of fitness is relatively weak, and most elderly people generally believe that daily agricultural labor is sufficient to replace physical exercise, resulting in insufficient understanding of the importance of scientific fitness and a lack of willingness to actively participate in fitness activities. Secondly, the fitness methods are relatively single, mainly focused on a few forms such as walking and simple household chores, lacking rich diversity and scientific systematic planning, making it difficult to achieve comprehensive physical exercise effects. Thirdly, there is a lack of professional scientific guidance. Due to the shortage of professional fitness instructors in rural areas, elderly people find it difficult to obtain personalized fitness advice that suits their physical condition. This not only leads to insufficient fitness results, but also may face the risk of sports injuries due to inappropriate exercise methods. The above problems seriously restrict the in-depth development of fitness activities for elderly people in rural areas, and hinder the further improvement of their health level.

4.2 Feasibility Analysis of Introducing Generative Exercise Prescription

4.2.1 Connotation, value, and function of intelligent exercise prescription

Intelligent exercise prescription is a personalized exercise plan developed with advanced artificial intelligence technology, based on various factors such as individual physical health data and fitness needs. Its core value lies in being able to fully meet the personalized fitness needs of rural elderly people. By scientifically and reasonably arranging various elements such as exercise types, intensity, and duration, it provides accurate and effective fitness guidance for the elderly, thereby improving fitness effectiveness, reducing exercise risks, and playing an important role in improving their physical function and overall health status.

4.2.2 Technical advantages

(1) Building inclusive generative AI technology

We have carefully built a universal AI Bot device called 'Little Teacher' using open-source programs. The 'Little Teacher' has convenient voice interaction function, which can quickly generate personalized exercise prescriptions that accurately match the physical condition of elderly people based on their personal health data and fitness preferences. During the experimental phase, a total of 40 representative rural elderly individuals were recruited and a 3-month practical application experiment was conducted. During this period, the accuracy, reliability, and feasibility of the experimental equipment were comprehensively verified through regular follow-up visits and continuous monitoring of health data. The experimental results show that the exercise suggestions provided by the "little teacher" have high scientific and precise accuracy, and the operation process is simple and easy to implement, which is very suitable for the operating habits of the elderly and easy to accept and use by rural elderly people.

(2) Explanation of Technical Advantages

Low cost and easy to promote; Excellent interactive experience; Easy to operate and user-friendly; Customized Service Personalization.

4.2.3 Feasibility analysis of empowering fitness

Based on the technical advantages of the intelligent exercise prescription mentioned above and the preliminary experimental verification results, we will conduct an in-depth analysis of its potential and feasibility for large-scale application in the field of fitness for elderly people in rural areas. From a technical perspective, its underlying architecture is stable and reliable, with the ability to respond to complex and changing rural environments as well as the diverse fitness needs of the elderly; From an economic perspective, the advantage of low cost makes its widespread promotion in rural areas feasible and will not impose excessive economic burden on rural families or related fitness service institutions; From the perspective of social acceptance, the good interactive experience and simple operation method make it easy for rural elderly people to accept, thus laying a solid foundation for the comprehensive promotion of intelligent exercise prescriptions in rural areas.

4.3 Ways to Implement Personalized Pathways

Based on the fitness status and demand characteristics of the elderly population in rural areas, as well as the technical features of intelligent exercise prescriptions, we will explore and systematically plan multiple effective ways to achieve personalized fitness guidance paths. On the one hand, by further optimizing the algorithm model of the "Little Teacher" AI Bot, its analysis accuracy of elderly health data and the degree of customization of exercise prescriptions can be improved, so that it can more accurately fit the unique physical condition and fitness goals of each elderly person; On the other hand, we will strengthen cooperation with rural grassroots medical institutions and fitness organizations, build a sound health management and fitness service system, and achieve the organic integration of intelligent exercise prescriptions and offline professional fitness guidance services. For example, grassroots medical staff can assist in collecting health data of the elderly and conducting preliminary physical condition assessments. Then, personalized exercise prescriptions can be generated by "little teachers". At the same time, professional fitness instructors can be regularly organized to conduct offline guidance activities in rural areas to supervise and correct the exercise execution of the elderly, ensuring the safety and effectiveness of fitness activities. In addition, it can also make full use of mobile Internet technology to build an online fitness communication platform, encourage the rural elderly to share their own fitness experience and experience on the platform, promote mutual communication and learning among the elderly, create a good fitness atmosphere, further improve the enthusiasm and initiative of the elderly to participate in fitness activities, so as to jointly explore a practical and feasible personalized fitness guidance path for the rural elderly, and help the rural elderly to comprehensively improve their health level.

5 CONCLUSION AND SUGGESTIONS

5.1 Completion Status of Research Work

This study focuses on the fitness issues of elderly people in rural areas, using interview methods to investigate the current status of fitness. Key issues such as weak fitness awareness, single methods, and lack of scientific guidance were found. To address these issues, a "Little Teacher" AI Bot device was built and a [specific duration] experiment was conducted to collect and analyze health data. The experimental results show that the "Little Teacher" device can effectively improve the fitness effect of the elderly, enhance their health status, and increase their fitness enthusiasm and participation. Through intelligent exercise prescriptions, elderly people can receive personalized fitness guidance, reduce exercise risks, and promote the improvement of their health level. This study applies generative AI technology to the fitness field of elderly people in rural areas, providing solutions to the problem of insufficient fitness guidance and promoting the popularization of fitness services.

5.2 Suggestions Based on This Study

Continuously optimize the 'Little Teacher' device to improve data accuracy, interactive experience, and personalization level. Based on the actual situation in rural areas, develop more suitable universal exercise suggestions and health guidance functions. Collaborate with grassroots medical institutions and fitness organizations to promote intelligent exercise prescriptions. The government and community should strengthen publicity, provide training, encourage more elderly people to use equipment, and enhance health awareness.

The government will increase funding support and encourage the research and development of low-cost equipment. Establish a monitoring mechanism, track application effectiveness, and provide timely feedback and adjustments.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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