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Physical Health Issues and Countermeasures for the Elderly in Highland Regions: A Study Based on the Integration of Sports and Health

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Abstract: Against the backdrop of accelerating population aging, the proportion of China's population aged 60 and older has reached 20%, far exceeding the international threshold of 14% for a deeply aged society. Due to their prolonged exposure to low oxygen levels, low atmospheric pressure, cold temperatures, and intense ultraviolet radiation, the elderly in plateau regions face unique health challenges, including declining cardiopulmonary function, reduced exercise tolerance, and a high risk of altitude-related illnesses. Based on the concept of "integration of sports and health," this paper systematically explores the physical health issues and corresponding strategies for the elderly in plateau regions. Research indicates that the integration of physical fitness and healthcare in plateau regions must adhere to a three-pronged approach combining "scientific evidence, cultural wisdom, and policy support". By scientifically adapting traditional activities (such as the Guozhuang dance and Kora (ritual circumambulation of sacred sites)) and establishing a three-tiered service framework of "basic universal services, cultural integration, and individualized customization", we can realize the vision of enabling the elderly to "age in good health, with joy, and with purpose", thereby providing a theoretical foundation for healthy aging in high-altitude regions.

1. Introduction

In recent years, China's population has been aging at an accelerating rate, with those aged 60 and older accounting for 20% of the total population—significantly exceeding the international threshold of 14% for a "deeply aged society" [1]. As the aging process accelerates, health issues among the elderly have become increasingly prominent, placing immense pressure on the traditional healthcare system. Consequently, how to maintain and improve the health of the elderly has become one of the key issues in China's proactive response to population aging. In March 2021, the "Outline of the 14th Five-Year Plan for National Economic and Social Development of the People's Republic of China and the Long-Range Objectives Through the Year 2035" proposed placing the protection of people's health at the forefront of strategic development, adhering to the principles of prevention-oriented and proactive health, and shifting the focus of health care to earlier stages. It introduced, for the first time, a new health governance strategy known as "integration of sports and health". Subsequently, the "Opinions on Building a Higher-Level Public Service System for National Fitness", issued by the

Central Committee of the Communist of China and the State Council, explicitly called for deepening the integration of sports and health, formulating and implementing an action plan for promoting health through exercise, and fostering a deep integration of national fitness and public health [2]. Since then, departments such as sports and health have collaborated to establish scientific fitness clinics within healthcare institutions, bringing new ideas to the practice of healthy aging.

Due to their long-term exposure to the high-altitude environment—characterized by low oxygen levels, low atmospheric pressure, cold temperatures, and intense ultraviolet radiation—elderly individuals in high-altitude regions have developed a series of unique physiological adaptive mechanisms. The cardiovascular, respiratory, and hematological systems of high-altitude residents exhibit specific adaptations, such as increased hemoglobin concentration, enhanced erythropoiesis, and elevated pulmonary artery pressure. These adaptive mechanisms enable high-altitude residents to maintain normal physiological functions in hypoxic environments. However, such adaptations are also accompanied by certain health risks, including chronic high-altitude diseases such as respiratory disorders (e.g., chronic obstructive pulmonary disease) and cardiovascular diseases. Furthermore, due to limited medical resources and poor transportation infrastructure, many residents are unable to access effective medical services in a timely manner. Consequently, the implementation of the "integration of sports and health" model in high-altitude regions may face significant challenges. This paper explores how the integration of sports and health can promote health management for urban elderly populations in high-altitude regions, clarifies its underlying logic, analyzes limiting factors, and identifies development strategies.

2. Key considerations in developing integrated sports and health management programmes for high-altitude regions

Health-centered aging is a model of elderly care that prioritizes the health of older adults, encompassing a range of services such as health education, preventive care, disease diagnosis and treatment, and rehabilitation nursing [3]. "integration of sports and health"is an emerging health management model that utilizes physical exercise as a means and healthcare as a safeguard to achieve non-medical health promotion, including disease prevention, chronic disease management, and post-illness convalescence and rehabilitation [4]. An integrated sports and health management programme involves developing scientific and systematic health management plans for the elderly population, combining physical activity with health management. These plans comprehensively consider the unique climate, geography, and environment of high-altitude regions, as well as the physiological characteristics of the elderly, with the aim of improving their overall health, enhancing physical fitness, preventing and alleviating chronic diseases, and elevating their quality of life. The implementation of this program in high-altitude regions integrates the unique characteristics of the high-altitude environment with the individual needs of the elderly. It is not merely a simple combination of physical intervention and medical management, but rather a comprehensive, dynamically adjusted systemic project involving multiple aspects such as exercise, nutrition, medical care, and mental health. Through the implementation of this program, it is possible to effectively improve the physical and mental health as well as the quality of life of the elderly in high-altitude regions, providing strong support for addressing the health challenges of an aging society.

2.1 The organic integration of health management and exercise intervention

The unique environmental conditions of high-altitude regions (such as low oxygen levels, extreme cold, and high elevation) affect the physiological functions of older adults, leading to issues such as decreased blood oxygen saturation, reduced cardiopulmonary function, and poor exercise endurance [5]. Therefore, exercise interventions play a central role in the integration of sports and health

management in high-altitude regions. Not only is exercise an effective means of preventing and treating chronic diseases, it also improves cardiovascular and pulmonary function, enhances muscle strength and increases endurance and physical coordination in older adults. Exercise interventions for older adults in high-altitude regions should be designed based on individual health status and physical fitness levels to ensure both safety and effectiveness. Types of exercise interventions may include: aerobic exercises, such as walking, cycling, and swimming, which help older adults improve their cardiopulmonary function; strength training, where moderate resistance training can increase bone density, prevent osteoporosis, and enhance muscle strength; and flexibility and coordination training, such as tai chi and yoga, which can improve balance and reduce the risk of falls.

2.2 Integrating nutrition and dietary management

Nutrition management is a crucial component of health management programs, particularly in high-altitude regions, where the nutritional needs of older adults are unique. Due to the thin air at high altitudes, the body must expend more energy to adapt to the low-oxygen environment; therefore, older adults need to pay even greater attention to a balanced diet and adequate nutrient intake. A reasonable dietary structure can help older adults boost their immunity, maintain basic metabolic functions, and reduce the incidence of chronic diseases [6]. Therefore, it is essential to make appropriate adjustments to the dietary habits of older adults. They should increase their intake of foods rich in protein, vitamins, and minerals—such as calcium-rich dairy products and fruits and vegetables high in vitamin C—to strengthen bones and boost immunity. At the same time, they should limit their intake of fat and salt. A diet high in salt and fat increases the risk of chronic diseases such as hypertension and heart disease.

2.3 Mental health and social support

As they age, older adults face mental health issues such as loneliness, depression, and anxiety [7]. Therefore, integration of sports and health management programs should not only focus on older adults' physical health but also strengthen the management of their mental health. Older adults in high-altitude regions may face greater psychological stress due to climatic conditions and cultural differences, making the establishment of a robust social support system crucial. Psychological Counseling and Support: Through regular psychological counseling, social activities, and mental health education for older adults, we can alleviate their feelings of loneliness and stress, thereby improving their mental health. Social Activities and Community Support: Encouraging older adults to participate in group activities, cultural events, and community organizations enhances their sense of belonging and social support, thereby improving their mental health.

2.4 Health management for adaptation to high-altitude environments

The unique conditions of high-altitude regions require that health management plans be appropriately adjusted to account for factors such as low oxygen levels and extreme cold. Since older adults have a lower capacity for adaptation, more tailored plans are needed in areas such as exercise, diet, and disease management to help them better adapt to high-altitude environments. Exercise Adaptation in Low-Oxygen Environments: When engaging in physical activity at high altitudes, older adults must gradually acclimate to the low-oxygen environment, avoid strenuous exercise and excessive fatigue, and ensure their safety. Impact of Climatic Factors on Health: The cold climate may exacerbate joint pain, respiratory issues, and other health conditions. Older adults need to pay special attention to environmental factors such as staying warm and maintaining adequate air humidity.

3. Challenges in developing integration of sports and health management programs in high-altitude regions

3.1 Physiological adaptation to the high-altitude environment

Due to natural environmental conditions such as low oxygen levels, cold temperatures, and high altitude in high-altitude regions, older adults have limited physiological adaptability, particularly in terms of cardiopulmonary function, exercise endurance, and muscle strength. Exercise interventions and health management programs must fully account for these environmental factors to avoid physical discomfort or health risks caused by excessive exercise. However, determining appropriate exercise intensity and types while ensuring safety remains a major challenge during implementation. Effects of Hypoxic Environments on Exercise: The hypoxic environment of high-altitude regions makes older adults more prone to breathing difficulties and accelerated heart rates; excessive exercise may exacerbate physical strain and adversely affect health [8]. Effects of Cold Climates on the Body: Cold weather places stress on older adults' joints, muscles, and immune systems; therefore, exercise programs must be designed to be gentle yet effective to prevent discomfort caused by temperature fluctuations.

3.1.1 Decline in cardiopulmonary function and high risk of acute mountain sickness

Prolonged exposure to the low atmospheric pressure and hypoxic environment of high-altitude regions requires the body to undergo adaptive adjustments to maintain oxygen supply; however, due to a significant decline in physiological reserve capacity, the adaptation process is more difficult for the elderly. Studies have shown that prolonged exposure to high altitudes leads to significant changes in cardiopulmonary function in healthy adults [9]: the hypoxic environment causes elevated pulmonary artery pressure and pulmonary vasoconstriction, directly affecting the heart's pumping function; simultaneously, reduced oxygen transport and utilization efficiency further exacerbate the burden on the cardiopulmonary system. The natural decline of the cardiovascular system in older adults weakens their ability to compensate for these stresses, significantly increasing the risk of complications such as heart failure. Consequently, older adults are more susceptible to altitude-related illnesses than younger individuals [10]. Acute Mountain Sickness (AMS), a common health threat in high-altitude regions, is fundamentally caused by insufficient oxygen supply due to low partial pressure of oxygen, leading to typical symptoms such as headache, nausea, and fatigue. Due to reduced physiological regulatory capacity, older adults experience symptoms earlier and with greater severity, and are more likely to progress to life-threatening complications such as high-altitude cerebral edema (HACE) or high-altitude pulmonary edema (HAPE) [10]. HACE manifests as cerebral edema, while HAPE involves pulmonary fluid accumulation; both require urgent medical intervention, placing extremely high demands on the establishment of safety thresholds for integrated physical and health management protocols.

3.1.2 Accumulation of subclinical damage to metabolism and visceral organ function

High-altitude environments also affect the gut microbiota of older adults [11]. The gut microbiota plays a crucial role in maintaining human health, participating in processes such as nutrient metabolism and immune system regulation. Studies have shown that the unique environmental stressors of high-altitude regions can significantly alter the composition of the gut microbiota and accelerate physiological aging [11]. Specifically, high-altitude environments may lead to reduced gut microbiota diversity, a decrease in certain beneficial bacteria, and an increase in harmful bacteria, thereby affecting normal intestinal function. This may result in issues such as indigestion and malabsorption of nutrients in older adults, further impacting their overall health. At the same time,

there is a clear association between living at high altitudes and kidney health. Although the detailed mechanisms require further investigation, it is reasonable to infer that systemic hypoxia caused by hypoxemia and hemodynamic changes resulting from increased cardiopulmonary workload both indirectly increase the burden on the kidneys. As the core organ responsible for regulating fluid and electrolyte balance and eliminating metabolic waste, the kidneys face persistent stress in high-altitude environments. Under long-term exposure, the risk of a decline in renal compensatory capacity increases significantly, necessitating their inclusion in the long-term monitoring system of integrated physical and mental health management programs.

3.1.3 Compound health threats from multiple environmental exposures

In addition to the primary effects mentioned above, high-altitude environments may also affect the physical health of older adults through other mechanisms. For example, ultraviolet radiation is stronger at high altitudes, which may increase the risk of skin cancer. Furthermore, climate-related changes in high-altitude regions, such as extreme temperature events and PM2.5 pollution, may also have adverse effects on the respiratory health of older adults [12]. A study conducted in Xining indicated that extreme temperature events and PM2.5 pollution have an interactive effect on outpatient visits for respiratory diseases among older adults [12].

3.2 The dual dilemma of health behavior participation among older adults

Older adults in high-altitude regions generally suffer from insufficient physical activity and poor balance [13]. Influenced by declining physical strength, health concerns, and traditional beliefs such as “exercise is harmful to health,” some older adults hold negative attitudes toward physical activity or even develop a fear of it. Existing exercise programs often overlook the varying physical conditions of older adults, and their intensity levels are poorly designed, resulting in exercises that are too difficult and fail to meet the needs of this population. In terms of nutrition, dietary imbalances are a prominent issue in high-altitude regions: the local food culture is relatively traditional, and older adults are generally reluctant to change their eating habits. High-fat, high-salt diets are difficult to alter, increasing the risk of chronic diseases. Additionally, there is a shortage of nutritional resources: poor agricultural production conditions in high-altitude regions result in an unstable supply of nutrient-rich foods (such as fresh vegetables and fruits), leaving older adults prone to deficiencies in essential vitamins and minerals.

3.3 Dual shortcomings in healthcare resources and technical support

In terms of resources, the healthcare service system in plateau regions is underdeveloped, making it difficult for the elderly in remote rural areas to access timely and professional healthcare services. There is a severe shortage of professionals in key fields such as geriatrics and rehabilitation medicine. Equipment availability rates at primary healthcare facilities are low, making it difficult to effectively implement the integrated physical and health intervention programs required by the “integration of sports and health” initiative. On the technical front, there are significant gaps in the health data monitoring system: coverage of basic monitoring devices—such as blood pressure monitors, blood glucose meters, and portable pulse oximeters—in townships is insufficient; IT infrastructure development lags behind, and telemedicine systems fail to function in low-temperature or offline environments, resulting in weak capabilities for data collection, transmission, and analysis. The combination of these factors leads to a lack of data support for developing personalized exercise prescriptions, makes it difficult to establish dynamic risk warning mechanisms, and undermines the safety and effectiveness of the program.

3.4 Structural deficiencies in multi-stakeholder collaboration mechanisms

The “integration of sports and health” is, by its very nature, a cross-sectoral systemic endeavor that requires coordinated efforts from multiple departments, including health, sports, civil affairs, and ethnic and religious affairs. However, in practice in plateau regions, there is a lack of regular coordination platforms and joint evaluation mechanisms. At the government level, there is an insufficient supply of specialized policies and limited financial support, with a lack of specific plans and funding dedicated to integrating physical activity and healthcare for the elderly in high-altitude regions. At the community and family levels, the elderly often rely on family care, but family members lack knowledge of health management, community health service networks are incomplete, and volunteer teams lack professional expertise. Government guidance, community organization, and family support have failed to form a cohesive force, resulting in a “fragmented” implementation of programs and posing severe challenges to sustainability.

3.5 A significant discrepancy between cultural adaptation and personalized services

Plateau regions possess a unique cultural ecosystem and system of health beliefs, yet existing health management programs often directly replicate lowland models, neglecting cultural adaptation. Health education employs Western medical metaphors such as “blocked blood vessels,” which are disconnected from the cognitive frameworks of the elderly, easily leading to comprehension barriers and psychological resistance; exercise programs fail to incorporate cultural practices such as Kora (ritual circumambulation of sacred sites) and Guozhuang dance, thereby reducing willingness to participate. At the same time, the physical conditions of the elderly are highly heterogeneous (e.g., differences in altitude acclimatization and varying patterns of chronic comorbidities). Given limited resources, it is difficult to implement precise, “tailored-to-the-individual” interventions. Constrained by both a lack of cultural respect and insufficient capacity for personalization, these programs face the dilemma of being “out of sync” with local conditions. There is an urgent need to establish a three-tiered service framework comprising “basic universal services + cultural integration + individual customization” to achieve an organic unity of scientific rigor and cultural identity.

4. Strategies for integrating sports and health management programmes in high-altitude regions

4.1 Exercise intervention and dynamic adaptation strategies for physiological challenges in high-altitude environments

The hypoxic environment in high-altitude regions significantly affects the physical performance of older adults; this must be fully taken into account when designing exercise intervention programs. Developing exercise plans suitable for older adults requires addressing the following aspects. For example, a gradual acclimatization program: Exercise interventions should be conducted in phases, starting with low-intensity activities and gradually increasing both volume and intensity to help older adults adapt to the hypoxic environment of high-altitude regions. In the initial stages, low-intensity aerobic exercises (such as walking, Tai Chi, or Baduanjin) can be selected, with exercise intensity gradually increased as adaptability improves. Moderate Exercise in a Hypoxic Environment: By conducting hypoxic training indoors or using hypoxic exercise equipment, older adults can better adapt to the high-altitude environment while avoiding the health risks associated with high-intensity exercise. Exercise Guidance and Monitoring: Leveraging modern technology and smart health devices to monitor exercise intensity, heart rate, blood oxygen levels, and other metrics in real time ensures the safety and effectiveness of the exercise intervention. After the program is implemented,

its effectiveness should be periodically evaluated using multidimensional indicators such as health checkups and exercise capacity assessments. Exercise intensity and type should be dynamically adjusted based on data such as changes in blood oxygen saturation and cardiopulmonary function responses in older adults, establishing a "monitoring-evaluation-optimization" closed-loop mechanism to ensure the program remains aligned with the dynamic changes of the high-altitude environment and the individual's physiological adaptation process.

4.2 Incentives and personalized strategies for health behavior participation and nutritional management

Older adults in high-altitude regions generally lack exercise habits; therefore, the developed program should emphasize incentive mechanisms to increase their participation in physical activity through the following approaches. For example: 1) Social support and mobilisation: Encourage older adults to participate in group and social activities (such as square dancing and group walking) through community activities and family support. Provide emotional support and enhance their sense of participation and belonging. 2) Health education and psychological support: Through community and health education initiatives, raise awareness among older adults of the benefits of exercise, help them to overcome psychological barriers to physical activity and alleviate fears and aversion towards exercise. 3) Advance personalised nutrition management: Develop culturally appropriate nutrition improvement plans based on the health status and lifestyle habits (particularly traditional dietary patterns) of older adults. We will periodically evaluate the effectiveness of physical activity interventions and continuously refine incentive measures and educational content by monitoring older adults' participation in physical activity, changes in nutritional indicators, and the outcomes of chronic disease management.

4.3 Integrated monitoring strategy combining medical resources and technological support

In order to address the challenges of collecting health data in high-altitude regions and the shortage of medical resources, health data monitoring systems must be improved. Specific measures include: 1) Using telemedicine and wearable devices to monitor older adults' physiological data in real time, transmitting it to telemedicine platforms or health management systems for periodic analysis and making personalised adjustments to health management plans based on the results. 2) Electronic health records should be established for each elderly individual, with their health status, physical activity levels and chronic disease management data being regularly documented. 3)integrating medical resources can improve access to healthcare services and develop telemedicine services, enabling older adults in high-altitude regions to receive professional medical guidance through video and telephone consultations. 4)Increase government investment in the construction of primary healthcare facilities in high-altitude regions and equip them with the necessary medical equipment and personnel to strengthen primary healthcare infrastructure. 5) Integrating community health service centres with home care services to establish a community health service network, thereby expanding the coverage and accessibility of healthcare services. 6) Establish a cross-sectoral health data-sharing platform (encompassing healthcare, sports, and social services) to ensure the effective utilisation of health data and collaboration among all parties. Regularly evaluate key indicators such as the coverage of monitoring equipment, the stability of telemedicine systems, and the responsiveness of primary healthcare services.

4.4 Innovative strategies for establishing a multi-Stakeholder collaborative governance mechanism involving government, communities, and families

Successful integration of sports and health management programmes in high-altitude regions requires collaboration between various stakeholders, including government bodies, local communities, families, and healthcare institutions. The government should introduce policies that provide financial support and policy safeguards, as well as stepping up public awareness campaigns regarding health management for the elderly. Community and social organisations should mobilise volunteers to participate in the health management of the elderly by offering services such as regular exercise guidance, health lectures and psychological counselling. Family support and participation is also crucial. Family members should actively engage in the health management of the elderly by providing daily care and emotional support and helping them adhere to exercise, dietary and health management plans. Furthermore, a regularised cross-departmental coordination platform involving departments such as health, sports, and civil affairs should be established. This platform should clarify the division of responsibilities and establish a joint evaluation mechanism that incorporates the outcomes of integrating physical fitness and health into the evaluation systems for rural revitalisation and the “Healthy China” initiative. This will foster sustainable synergy between government guidance, community organisation and family support.

4.5 Innovative strategies for deepening the integration of cultural adaptation and personalized services

High-altitude regions have unique ethnic cultures and traditional customs. Therefore, health management programmes must take cultural factors fully into account when designing exercise intervention plans, ensuring they align with local cultural characteristics. For instance, incorporating traditional dance (such as Guozhuang dance) alongside physical activities (prayer wheel walking training) can meet the exercise requirements of older adults while fostering a sense of ownership and engagement in health management. Furthermore, we can develop personalised health management plans for elderly participants based on their health status, physical capabilities and lifestyle habits, ensuring the interventions are effective and applicable. We can also implement precise interventions tailored to heterogeneous characteristics, such as differences in altitude acclimatisation and the spectrum of chronic comorbidities, by establishing a three-tiered service framework of 'universal foundation + cultural integration + individual customisation'. Finally, we will evaluate the effectiveness of the culturally adapted and personalised programmes across multiple dimensions, including cultural acceptance, programme adherence and improvement rates in health indicators. By continuously optimising service content and delivery methods, we can achieve an organic integration of scientific intervention and cultural identity, thoroughly resolving the challenge of “cultural mismatch”.

5. Conclusions

Health issues among the elderly in the Plateau region are characterised by two distinct features: ‘accelerated functional decline due to hypoxic environments’ and ‘deep integration with ethnic culture’. The integration of sports and health practices must overcome four core challenges: physiological adaptation; resource and technology constraints; collaborative mechanisms; and cultural compatibility. The study proposes the establishment of a three-tiered service framework comprising 'basic universal services + cultural integration + individualised customisation'. It advocates for the scientific adaptation of traditional activities such as the Guozhuang dance and Kora to achieve the organic integration of exercise prescriptions with ethnic culture. This research not only

provides a replicable pathway for healthy aging in plateau regions but also enhances older adults' sense of fulfillment and ethnic identity through health empowerment.

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