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# Enhancing Elderly Care Efficiency Through Artificial Intelligence: A Precision Empowerment Model Based on Health Grading for the Elderly

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**Abstract:** The application of artificial intelligence (AI) in elderly care services is an emerging research domain, yet existing studies remain limited. Few investigations have explored how AI can enhance care pathways for elderly populations with varying health statuses through the lens of health grading. To advance this field, this paper first examines how AI can empower elderly individuals with different health conditions by simplifying daily tasks, providing emotional support, managing chronic conditions, and enabling alternative interventions, thereby significantly improving the quality and efficiency of care services. Second, the adoption of AI in elderly care faces challenges on both the supply and demand sides, including inadequate technical and product compatibility, low user acceptance, and limited financial capacity. Finally, this paper proposes strategies to address these challenges, including enhancing the reliability of AI technologies and products, improving digital literacy among the elderly, and incorporating AI-based elderly care services into medical insurance or fiscal subsidy programs.

**Keywords:** Artificial Intelligence; Elderly Care Services; Health Grading; Ageing Society.

## 1. Introduction

With the acceleration of global population ageing, elderly care has become a critical issue faced by nations worldwide. According to data from the National Bureau of Statistics, China's total population at the end of 2024 reached 1,408.28 million, including 220.23 million people aged 65 and above, representing an elderly dependency ratio of 22.8%. This indicates that China has entered a stage of profound ageing, characterised by a large and continuously expanding elderly population. Consequently, the demand for social security, healthcare, and care services is growing rapidly. The Opinions on Deepening the Reform and Development of Elderly Care Services, issued by the Central Committee of the Communist Party of China, call for accelerating the establishment of a comprehensive elderly care service network. This initiative aims to optimise the service structure, enhance quality and efficiency, and ensure that a preliminary service network is in place by 2029, with a mature and well-developed system by 2035. Against this backdrop, effectively addressing elderly care has become an urgent challenge for policymakers worldwide.

Concurrently, the rapid advancement of artificial intelligence (AI) technology presents unprecedented opportunities for innovation within the silver economy. AI can enhance the quality of life for older adults while driving industrial upgrades across multiple sectors, including healthcare, wellness, elderly care, and smart homes. Particularly within the elderly care services domain, AI applications demonstrate immense potential. Existing research indicates that digital and intelligent technologies can comprehensively empower the entire silver economy value chain, encompassing production, distribution, exchange, and consumption [1]. Within the smart elderly care field, key directions include age-friendly intelligent product design, data-driven service delivery, and digital divide governance. Furthermore, research on emerging technologies such as generative AI and immersive virtual reality has grown significantly, while traditional topics like economic benefit analysis have received less attention [2]. Huang Xin (2020) notes that "AI-enhanced elderly care" services can effectively improve service quality, enhance regulatory efficiency, meet seniors' emotional needs, and enrich care provision [3]. Similarly, He Ni (2021) argues that AI applications in elderly care primarily improve service quality by enhancing the functionality of products designed for emotional comfort and emergency assistance [4]. Nie Jianliang and Xue Mengyao (2025) emphasise that artificial intelligence facilitates the effective delivery of elderly care services [5]. However, some studies caution that the widespread adoption of intelligent technologies may lead to digital exclusion among the elderly, data security risks, and algorithmic biases, while also posing ethical challenges for families and society [6].

The application of artificial intelligence (AI) to enhance elderly care services represents an emerging research field, with existing studies remaining relatively scarce. Few investigations have examined how AI can empower care pathways for elderly populations with varying health statuses from the perspective of health grading. To advance this field, this paper explores how AI can enhance the efficiency of elderly care services across different health levels based on health stratification. It further analyses existing challenges and constraints and proposes optimisation strategies and policy recommendations, aiming to provide a theoretical foundation and practical guidance for improving the quality and efficiency of elderly care services.

## 2. Pathways for Artificial Intelligence to Enhance Elderly Care Service Efficiency

In enhancing the efficiency of elderly care services, artificial intelligence (AI) should provide tiered and differentiated intelligent support tailored to seniors' health conditions and self-care capabilities. To systematically improve service efficiency, this study proposes a three-tier

classification model based on health grading. This model serves as the foundation for constructing differentiated empowerment pathways, enabling precise resource allocation and maximising service efficiency.

## 2.1. Elderly Individuals in Good Health

Elderly individuals in good health constitute a pivotal group within the elderly care service system, as they are essential for maintaining social engagement and delaying functional decline. Artificial intelligence (AI) plays a significant role in their daily lives and health management by supporting prevention and empowerment.

Firstly, through tools such as smart home voice control, integrated lifestyle service applications, and automated appliance management, artificial intelligence (AI) can significantly streamline the daily routines of elderly individuals, thereby reducing their burdens. For example, seniors can manage everyday tasks such as lighting, temperature regulation, and cooking without frequent manual operation of appliances. At the same time, mobile applications enable centralised management of shopping, payments, and health reminders, allowing one-stop completion of routine activities. This not only alleviates physical and cognitive strain but also reduces the stress associated with daily chores, enabling older adults to devote more energy to leisure, social interaction, and health management. Consequently, their quality of life and personal autonomy are enhanced.

Furthermore, the application of artificial intelligence (AI) in emotional companionship and social interaction provides crucial emotional support for the elderly, particularly those living alone. For example, electronic pets can alleviate loneliness through intelligent interaction and emotional simulation. These devices engage with the elderly via voice, movement, and facial expressions, offering sustained emotional companionship that compensates for gaps in real-world social connections. Compared to real pets, electronic companions require no feeding or cleaning, are easy to operate, and are well-suited for elderly individuals with limited physical capacity or those living alone. Their intelligent features can respond to changes in the user's tone and behaviour, creating a psychological experience of being understood and cared for, thereby reducing loneliness and anxiety. In addition, electronic companions can provide daily reminders and recreational interaction, encouraging older adults to maintain healthy routines and emotional wellbeing. Overall, electronic pets deliver emotional support and comfort in a low-risk, low-burden manner, enhancing both quality of life and mental health for the elderly.

Finally, intelligent health management uses smart monitoring devices, wearables, and sensors to collect real-time health data from elderly individuals. By leveraging intelligent algorithms, it establishes personalised health baselines for dynamic monitoring and early risk alerts, providing tailored health warnings and management recommendations. For example, smartwatches can track physiological indicators such as heart rate and blood glucose levels, issuing timely alerts to remind users to take medication or engage in appropriate physical activity. This approach not only helps the elderly maintain their health but also effectively prevents the onset of chronic diseases and sudden health issues, shifting care from reactive treatment to proactive prevention and thereby extending healthy lifespan. Moreover, AI-driven health management can integrate with healthcare institutions and community health service platforms to offer continuous guidance and remote consultations, supporting long-term independent living and active social participation among older adults.

Therefore, for healthy elderly individuals, artificial intelligence focuses on streamlining daily routines, reducing the burden of daily living, providing emotional support and social interaction, and preventing illness. It emphasises AI's role in delaying ageing and enhancing convenience for healthy seniors.

## 2.2. Elderly Individuals with Illnesses but Capable of Self-Care

For elderly individuals who remain capable of self-care despite illness, AI empowerment focuses on multiple objectives: disease management, daily living support, and psychological assistance. Through precise monitoring, intelligent interventions, and accessible services, AI enables them to live safely and independently while managing their health conditions. First, AI functions as a "general practitioner nurse + vigilant sentinel" in health management. Using medical-grade devices such as smart blood pressure monitors, glucose meters, and ECG patches, it collects real-time vital signs, including heart rate, blood pressure, and blood glucose levels. Intelligent algorithms dynamically track disease progression, identify potential risks (e.g., abnormal signals such as atrial fibrillation), provide automated medication reminders, and generate personalised health reports for medical professionals. Through this routine health monitoring and condition management, AI facilitates precise disease control, emphasising managing existing conditions and preventing deterioration to stabilise the health status of elderly individuals.

Second, at the level of daily living support, artificial intelligence (AI) enhances the safety and convenience of elderly individuals' routines through low-cost, highly accessible services. For example, intelligent dispatch systems optimise community meal delivery, medication distribution, and home rehabilitation services, while voice assistants provide simplified functions such as shopping and GP consultations. These solutions ensure that even when managing illness, older adults can easily meet their basic needs, reducing the impact of illness on daily life and enhancing both independence and quality of life.

Finally, artificial intelligence (AI) also plays a crucial role in psychological and emotional support. Through daily caring interactions, mood prompts, meditation, and soothing music, AI provides comfort and reassurance, helping to alleviate anxiety or distress related to illness. This integrated empowerment model, combining dynamic monitoring, daily living support, and emotional companionship, not only enables meticulous management of health and daily activities but also delivers essential emotional support. It allows elderly individuals who are ill yet capable of self-care to maintain an independent, stable, and reassuring lifestyle despite the challenges posed by their condition.

## 2.3. Elderly Individuals with Illnesses and Inability to Care for Themselves

For elderly individuals with illnesses and an inability to care for themselves, the empowerment of artificial intelligence primarily revolves around the concept of "substitution and intervention." This approach aims to compensate for their diminished physical and cognitive

functions, ensuring basic safety and dignity in daily life while significantly alleviating the physical and mental burden on caregivers.

First, in terms of physical function substitution, artificial intelligence acts as an extension of the elderly person's body. Through devices such as intelligent transfer machines and AI feeding robots, it assists with high-intensity daily tasks such as mobility, turning, and feeding, enabling incapacitated elderly individuals to retain basic self-care capabilities. At the same time, these technologies substantially reduce the physical strain and occupational risks faced by caregivers, effectively compensating for the diminished functional abilities of highly dependent individuals.

Second, in the realm of comprehensive safety monitoring and health management, artificial intelligence (AI) serves as an ever-vigilant guardian. By leveraging environmental sensors, smart mattresses, and computer vision technology, AI enables 24/7 unobtrusive monitoring of elderly individuals. It can detect falls, prolonged immobility, pressure ulcer risks, or abnormalities in vital signs in real time, automatically triggering alerts. At the same time, the system assists clinicians in developing personalised care plans, facilitating dynamic management of health risks. This passive and continuous monitoring, combined with automated response mechanisms, ensures comprehensive protection of the life and safety of elderly individuals with disabilities.

Furthermore, in terms of cognitive and emotional support, artificial intelligence (AI) functions as both a cognitive aid and an emotional companion. For elderly individuals with dementia or cognitive impairment, AI can deliver medication reminders, schedule guidance, and cognitive training (such as nostalgia therapy programs) through smart speakers to help maintain daily cognitive function. At the same time, companion robots can engage in simple conversations and provide emotional comfort, alleviating anxiety, agitation, and loneliness while enhancing psychological well-being and overall life satisfaction.

In summary, for this highly dependent group, artificial intelligence (AI) not only compensates for diminished physical and cognitive capacities but also provides comprehensive support in daily supervision, health management, and emotional companionship. This constitutes a highly specialised, strongly dependent, and continuous empowerment system aimed at safeguarding the fundamental survival, security, and dignity of elderly individuals while substantially reducing the burden on caregivers. In this context, AI functions as an indefatigable full-time carer and cognitive support tool, advancing elderly care services toward greater intelligence, professionalisation, and efficiency.

# 3. Challenges and Constraints in Enhancing Elderly Care Service Efficiency through Artificial Intelligence

## 3.1. Supply-Side Challenges: Mismatch Between Technology and Products

In the process of leveraging artificial intelligence (AI) to empower elderly care, despite its immense technological potential, multiple obstacles and constraints persist. These challenges primarily concern the compatibility between supply-side technologies and products, which can be examined across four key dimensions: technological maturity, interactive experience, system robustness, and product design.

First, issues of technological maturity and reliability constrain the effective application of artificial intelligence (AI) in elderly care settings. The complex living environments and diverse habits of the elderly limit the ability of sensors and computer vision systems to accurately detect behavioural anomalies. For example, a slow fall may be misinterpreted as sitting down, resulting in high false alarm rates or missed detections that undermine user trust. At the same time, natural language processing technology remains insufficient for recognising elderly speech characterised by accents, uneven speaking pace, or discontinuous logic. Touchscreen interfaces are also unfriendly to those with limited finger dexterity, and poor interaction experiences directly reduce willingness to use such products. Moreover, elderly users generally have low tolerance for device malfunctions; frequent crashes, complicated updates, or restart procedures can easily cause frustration, fostering resistance toward AI-enabled equipment.

Second, inadequate product design and insufficient age-friendly features also present significant constraints. Many smart products fail to adequately consider older adults' cognitive capacities, declining vision and hearing, and their apprehension toward technology, thereby widening the digital divide into a practical usage gap. Problems such as excessively small interface fonts, complicated operational procedures, overly rapid voice prompts, and an excess of non-targeted functions create substantial difficulties for elderly users, reducing both the usability and attractiveness of these products.

In summary, although artificial intelligence (AI) holds great potential for enhancing elderly care services, its implementation faces multi-layered and multi-dimensional challenges. These include technological immaturity, suboptimal user interaction experiences, insufficient system robustness, and limitations in product design. Such issues not only affect the acceptance and utilisation of AI products among the elderly but also limit the feasibility of achieving precise empowerment and large-scale deployment of AI within the elderly care sector. Going forward, systematic improvements in technological optimisation, age-friendly design, user education, and cost management are essential to fully realise AI's potential in efficiently empowering elderly care services.

## 3.2. Demand-Side Challenges: The Dual Barriers of User Acceptance and Payment

In leveraging artificial intelligence (AI) to enhance elderly care, demand-side challenges must not be overlooked. These challenges primarily arise from insufficient acceptance and trust among elderly users, combined with limited payment capacity and willingness. Together, these factors create a dual barrier that impedes the widespread adoption and application of AI technologies.

First, user acceptance and trust constitute major barriers. Many elderly individuals exhibit psychological resistance or apprehension toward new technologies, being accustomed to traditional interpersonal interactions and lifestyles. They are often reluctant to actively engage with smart devices, and this resistance, coupled with reliance on established habits, limits the practical application of artificial intelligence (AI). At the same time, older adults are highly sensitive to privacy and data security, expressing concerns that sensitive information—such as health data and daily activities—may be leaked or misused. Continuous monitoring may also evoke

feelings of intrusion, undermining their sense of privacy and dignity and further eroding trust in AI products. Additionally, elderly users may experience "de-skilling" anxiety, fearing that over-reliance on smart devices could diminish their own life skills and cognitive abilities. These concerns collectively encourage a cautious approach to adopting AI technologies.

Second, constraints on both payment capacity and willingness to pay further impede the adoption of AI-enabled elderly care products. Many elderly individuals have fixed and limited incomes, combined with conservative spending habits, resulting in low willingness to invest in non-essential smart devices. Even when certain products provide clear convenience or health benefits, if these advantages are not immediately evident, seniors may perceive them as "not worth the price," reducing their willingness to adopt such technologies. Moreover, the majority of AI health products and services are currently excluded from national basic medical insurance coverage, requiring individuals to bear the full cost. This significantly increases the financial burden and constitutes a major barrier to widespread adoption.

In summary, demand-side barriers primarily arise from a combination of psychological and cognitive factors, trust and privacy concerns, and limited payment capacity and perceived value. These issues not only affect elderly individuals' acceptance of artificial intelligence (AI) technologies but also constrain their promotion and sustainable use within elderly care settings. Therefore, advancing the application of AI in elderly care requires gradually addressing demand-side resistance through measures such as user education, the development of trust mechanisms, privacy protection, and optimisation of payment policies, thereby achieving effective alignment between technology and users.

# 4. Optimisation Strategies and Policy Recommendations for Enhancing Elderly Care Service Efficiency through Artificial Intelligence

Building on the previously proposed health-tiered precision empowerment model for the elderly, artificial intelligence (AI) can provide differentiated and targeted support within elderly care services. However, practical implementation continues to face multiple challenges, including technological adaptation, user acceptance, ethical considerations, and social equity. Therefore, optimisation strategies are necessary to further enhance the efficiency of elderly care services and to establish an intelligent, sustainable care service system.

First, regarding technology and products, the maturity and reliability of artificial intelligence (AI) systems should be continuously improved, with particular attention to enhancing sensor accuracy, computer vision recognition, and natural language processing to accommodate the complexity and diversity of elderly care environments, both at home and in care facilities. At the same time, systematic age-friendly design standards should be advanced, optimising interface layouts, font sizes, operational workflows, and voice prompt speeds to improve usability and interaction experiences for elderly users. To reduce the cost of high-end equipment and expand accessibility, models such as government subsidies, equipment leasing, shared usage, and public–private partnerships may be explored, facilitating the large-scale promotion and inclusive application of AI-powered elderly care products.

Second, regarding user acceptance and trust, systematic digital literacy education for the elderly should be implemented to enhance their understanding of and proficiency with smart technologies. At the same time, robust privacy protection and data security mechanisms must be established, with clear regulations governing the collection, use, and storage of personal information. Artificial intelligence (AI) services should function primarily as auxiliary tools rather than complete substitutes for human interaction. By integrating emotional companionship and cognitive support, these services can alleviate psychological resistance and anxieties about de-skilling among older adults, while simultaneously strengthening their trust in and acceptance of technology.

Furthermore, in terms of payment and safeguards, efforts should be made to include certain AI-powered elderly care services within the national medical insurance scheme or fiscal subsidy framework, thereby lowering the usage threshold for older adults. At the same time, a systematic evaluation mechanism should be established to demonstrate the tangible value of AI technologies in health management, daily convenience, and safety assurance, enhancing the willingness of elderly individuals and their families to pay. Additionally, differentiated subsidy policies could be implemented to prioritise coverage for low-income, incapacitated, or rural elderly populations, promoting the equitable and widespread adoption of AI-enabled elderly care services.

# 5. Conclusion

This paper examines pathways for enhancing the efficiency of elderly care services through artificial intelligence (AI), as well as the associated challenges and constraints, and proposes corresponding optimisation strategies and policy recommendations. In terms of implementation pathways, AI can significantly improve the quality and efficiency of elderly care services by empowering diverse groups of older adults with varying health conditions across multiple dimensions, including streamlining daily routines, providing emotional support, managing illnesses, and offering substitution and intervention services. However, practical application faces dual challenges on both the supply and demand sides. Mismatches between supply-side technologies and products, along with demand-side constraints such as limited user acceptance and payment capacity, remain key factors limiting the development and widespread adoption of AI in elderly care.

In response to these challenges, this paper proposes several optimisation strategies and policy recommendations. First, the maturity and reliability of artificial intelligence (AI) technologies and products should be enhanced to better meet the needs of the elderly population. Second, digital literacy education for older adults should be strengthened to improve their understanding of and ability to utilise smart technologies. Third, at the payment and security level, certain AI-based elderly care services should be incorporated into medical insurance or fiscal subsidy schemes to lower usage barriers and increase acceptance among the elderly.

This study holds significant theoretical value and practical implications. First, at the theoretical level, AI-enabled elderly care services have emerged as a global frontier topic. However, existing research predominantly focuses on technological applications and service model innovations,

lacking systematic exploration of AI's differentiated mechanisms across elderly populations with varying health statuses from a health-tiered perspective. This paper adopts health stratification as its entry point to construct an analytical framework for AI intervention in elderly care services, revealing AI's pathways of action in simplifying daily tasks, providing emotional support, managing chronic diseases, and delivering substitute interventions. This analysis not only broadens the research horizon of smart elderly care but also offers new theoretical support for understanding AI's functional boundaries and collaborative mechanisms within healthy aging systems. Secondly, at the practical level, facing the dual challenges of accelerating population aging and insufficient elderly care resources, leveraging AI technology to enhance the quality and efficiency of elderly care services has become an urgent priority. Through a systematic examination of AI's application potential and practical constraints in elderly care, this paper identifies key barriers on both the supply and demand sides, such as insufficient technological compatibility, low user acceptance, and limited financial capacity among the elderly. It further proposes optimization pathways, including enhancing the reliability and accessibility of AI products, improving digital literacy among seniors, and refining fiscal and medical insurance support systems. These recommendations offer actionable guidance for government policy formulation, corporate product innovation, and social organization participation in elderly care services.

Future research may further explore pathways for the deep integration of artificial intelligence within ageing societies, particularly concerning how policy innovation can drive the widespread adoption of AI within elderly care. In this regard, scholars could investigate how institutional frameworks, regulatory mechanisms, and ethical standards can be adapted to foster responsible and equitable AI deployment across diverse socio-economic contexts. Moreover, interdisciplinary approaches that combine insights from computer science, gerontology, public policy, and behavioral economics may help clarify how AI technologies can be customized to meet the complex and heterogeneous needs of older adults. At the same time, as technology continues to evolve, the role of artificial intelligence in care services will inevitably deepen. Future studies could examine how emerging technologies—such as generative AI, affective computing, and intelligent robotics—can complement human caregivers by providing emotional companionship, cognitive stimulation, and personalized health management. In addition, attention should be given to issues of accessibility, affordability, and digital literacy to ensure that technological progress benefits all segments of the ageing population, including those who are socially or economically disadvantaged. Ultimately, it is expected that artificial intelligence will play an increasingly significant part in enhancing the quality of life for older adults, alleviating the burden of care on families and professionals, and reducing societal costs associated with ageing. By integrating technology, policy, and human-centered design, future research can contribute to the development of sustainable, inclusive, and compassionate AI-enabled care ecosystems that support active and dignified ageing.

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