

Current Application Status and Future Prospects of Smart Elderly Care in Shanghai

Yiyun Chen, Hanqing Zhuang, Jinqi Liu, Jianwen Gao*

College of Health Management, Shanghai Jian Qiao University, Shanghai 201306, China

*Corresponding author: Jianwen Gao, 22608@gench.edu.cn

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Abstract: This paper systematically analyzes the development status, challenges, and future pathways of smart elderly care in Shanghai. As one of the cities with the most severe aging populations in China, Shanghai faces significant challenges such as a surge in chronic disease management demands and difficulties in the integration of healthcare and elderly care services. Research indicates that Shanghai has established a development framework led by the government with multi-stakeholder participation, applying technologies such as IoT monitoring, AI-based early warning systems, and big data analytics in home-based, community-based, and institutional elderly care. Key technologies include real-time fall detection algorithms (with an accuracy of 89.99%), voice emotion recognition systems, and positioning systems, which have effectively optimized medical resource allocation and improved care efficiency. However, the development of smart elderly care still faces challenges: inconsistent technical standards leading to system compatibility issues, prominent risks in elderly privacy protection and data security, the digital divide limiting service acceptance among the elderly, and a lag in the training system for professional caregivers. To address these issues, the study recommends strengthening policy support and financial investment, promoting interdisciplinary technology integration and innovation, and building a nationwide smart elderly care ecosystem. This paper argues that by improving technical standards, bridging the digital divide, and enhancing talent cultivation, smart elderly care will become a crucial strategic pathway to address the challenges of an aging population. Shanghai's experience provides valuable insights for the development of smart elderly care across the country.

Keywords: Smart elderly care; Shanghai; Aging population; Internet of Things; Artificial intelligence; Digital divide

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1. Introduction

1.1. Impact of population aging on Shanghai

Global population aging has become an irreversible trend. As one of the countries with the largest elderly population and the fastest aging rate in the world, China is facing severe challenges^[1]. According to the 2024 statistical survey by the National Bureau of Statistics, the population aged 60 and above in China was 310.31

million, accounting for 22.0% of the total national population, of which the population aged 65 and above was 220.23 million, accounting for 15.6% of the national population. **Figure 1** shows the growth trend of the population aged 65 and over in China (2015–2025).

As one of the first cities in China to enter an aging society, Shanghai’s healthcare and elderly care systems are under tremendous pressure. With the increasing number of elderly patients with chronic diseases, the traditional healthcare and elderly care service systems are struggling to meet the continuously growing care demands [2]. Eighty percent of elderly patients require long-term medical care, which poses urgent requirements for the allocation of medical resources and innovation in service models in Shanghai [1]. Concurrently, the healthcare system is also facing multiple challenges, including continuously rising medical costs and a shortage of professional nursing staff [3].

1.2. National strategic demand for intelligent transformation

In response to the systemic challenges brought by population aging, developing a smart elderly care service system has become a national strategic demand. The “14th Five-Year Plan” for the Development of National Aging Affairs explicitly proposes the deep integration of the internet, big data, artificial intelligence, and other technologies with elderly care services. Smart elderly care systems, by enabling real-time interaction among the elderly, communities, and medical personnel, can significantly enhance care efficiency and service quality. This transformation is not only an inevitable choice for addressing labor shortages but also a critical pathway to achieving the goal of healthy aging [2].

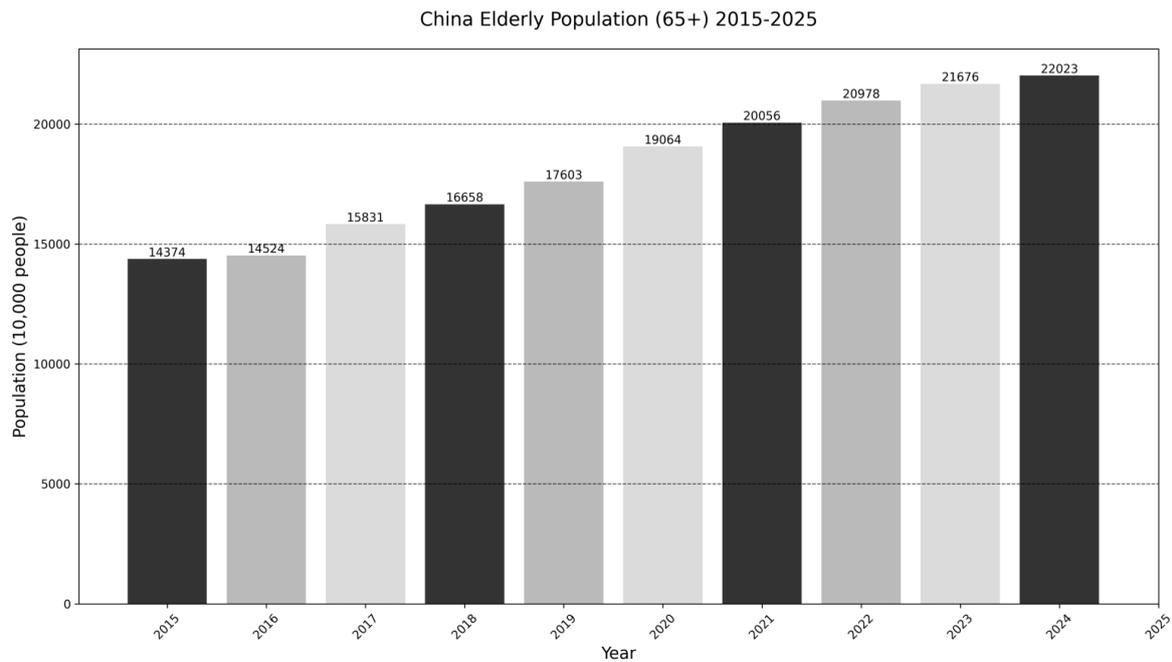


Figure 1. Growth trend of the population aged 65 and over in China (2015–2025)

2. Current development status of smart elderly care

2.1. Definition and technological scope of smart elderly care

Smart elderly care refers to a new model that utilizes modern information technology to provide intelligent and

personalized elderly care services ^[4]. Its technological scope encompasses multiple fields such as the Internet of Things (IoT), artificial intelligence (AI), and big data ^[5]. Following the implementation of these technologies, intelligent applications such as rehabilitation robots and other smart devices have emerged.

Specifically, IoT technology enables intelligent monitoring of the home environment; artificial intelligence plays a key role in health early warning systems; and big data support facilitates the construction of personalized elderly care service models ^[6]. These technologies enable real-time interaction among the elderly, communities, and medical personnel through means such as smart homes, wearable devices, and remote medical monitoring ^[2].

Smart elderly care equipment includes not only hardware facilities such as rehabilitation robots and exoskeleton devices, but also software systems such as health intelligent applications, voice-activated devices, and virtual reality ^[6]. Together, these technologies support the elderly in achieving “aging in place” and maintaining their ability to live independently ^[7], while simultaneously closely connecting families, communities, and hospitals, thereby greatly improving the efficiency of elderly care services.

2.2. Development status of smart elderly care in Shanghai

As a city with the highest level of economic development and the strongest scientific and technological innovation capability in China, as well as one of the first and most severely aging cities in the country, Shanghai has faced unprecedented pressure on its elderly care system over the past decade. Shanghai has adopted many active measures in responding to population aging ^[8].

Shanghai not only possesses a well-established medical infrastructure but also strong scientific research capabilities and industrial transformation capacity, providing a solid foundation for the development of smart elderly care ^[5]. The Shanghai municipal government has introduced multiple policies to support the development of the smart elderly care service industry, including establishing special scientific research funds and constructing demonstration projects ^[4]. It is particularly noteworthy that programs such as the Shanghai “Science and Technology Innovation Action Plan” and the “Special Program for Aging, Maternal and Child Health Research” have provided important support for the research, development, and application of smart elderly care technologies ^[8], forming a development pattern led by the government with multi-stakeholder participation.

A comparative analysis of Shanghai’s existing elderly care models reveals that the home-based care model primarily integrates smart wearable devices ^[12] and remote health monitoring technologies ^[7]; the community-based care model places greater emphasis on intelligent operation and technology integration, while institutional care emphasizes multi-technology system integration ^[13]. In terms of the degree of technology integration, municipal-level demonstration projects generally adopt interdisciplinary methods ^[11]. For instance, the industry-academia-research collaboration projects carried out by Shanghai Jiao Tong University ^[14] exhibit the highest level of integration, whereas ordinary elderly care institutions still face system compatibility issues ^[13]. It is noteworthy that technology integration in demonstration zones, such as Xuhui District, has already formed standardized solutions ^[9], while pilot projects in suburban areas are still in the technology adaptation stage ^[10].

3. Technology introduction and applications

3.1. Introduction to emerging technologies

3.1.1. Real-time fall detection algorithm

The vision-based real-time fall detection algorithm ingeniously combines traditional image processing

techniques like background subtraction with the lightweight BlazePose human pose estimation model. Utilizing biomechanical features extracted from human key points, it performs classification through a cascaded random forest. Ultimately, it achieves an accuracy rate as high as 89.99% and a real-time performance of 29.7 FPS on an ordinary laptop CPU, demonstrating excellent practicality^[15].

3.1.2. IoT emotion control method and system

A study has proposed an IoT emotion recognition control method and system for smart elderly care homes, focusing on emotion analysis technology based on voice signals. To address the need for monitoring the emotional states of the elderly in home environments, the system selects five primary emotions—happiness, sadness, anger, calm, and surprise—as recognition targets and has constructed a mixed voice emotion database suitable for home scenarios. Regarding feature extraction, Mel-frequency cepstral coefficients (MFCC) are adopted as the core feature parameters. These parameters align with the characteristics of human auditory perception and can effectively capture paralinguistic emotional information in speech. The system extracts 12–16-dimensional MFCC features through a series of processing steps, including voice signal digitization, preprocessing (comprising pre-emphasis, framing, and windowing), Fast Fourier Transform (FFT), Mel-frequency conversion, logarithmic energy calculation, and discrete cosine transform, which are then used for subsequent emotion classification. This technology provides a feasible path for non-intrusive, natural interaction-based emotional monitoring of the elderly and smart home control, offering high practical value and scenario adaptability^[16].

3.1.3. Smart elderly care system solution based on RFID and ZigBee integration technology

The smart elderly care system solution generated based on the integration of RFID and ZigBee technologies aims to enhance the management efficiency of elderly care institutions and the safety assurance level for the elderly. By deploying RFID readers within nursing homes and combining them with smart tags (such as wristbands or chest cards) integrated with ZigBee modules worn by the elderly, the system achieves the integration of multiple functions, including identity recognition, real-time positioning, health monitoring, and emergency rescue for the elderly. RFID technology is responsible for the contactless collection of personnel identity and location information, while the ZigBee network is responsible for building a low-power, self-organizing wireless data transmission channel to upload information in real-time to the backend management system. The system supports functions such as access control permission management, activity trajectory tracking, health data (e.g., heart rate, blood pressure) monitoring, and a one-key alarm, and can quickly locate the individual and initiate rescue procedures in emergency situations. This solution offers advantages like flexible deployment, timely response, and comprehensive coverage, providing viable IoT technical support for elderly care institutions, while also facing practical challenges such as device compatibility, data security, and cost control^[17].

3.2. Implemented technologies and their applications

3.2.1. Application of IoT technology in home care

As the foundational support for smart elderly care, IoT technology achieves comprehensive monitoring of the home environment for the elderly through the deployment of various smart sensor devices. These devices include wearable health monitoring devices, environmental sensors, and smart home control systems, capable of collecting the elderly's physiological parameters (such as heart rate, blood pressure, and blood oxygen), activity trajectories, and living environment data (temperature, humidity, air quality, etc.) in real-time^[2,18]. It is particularly

noteworthy that IoT technology enables nursing robots to seamlessly integrate with the home environment, forming a networked smart elderly care system that realizes the coordinated operation of health monitoring, ability assessment, and intelligent resource allocation^[18]. In application practices in Shanghai, IoT technology has successfully enabled real-time interaction among the elderly, communities, and medical personnel, significantly improving the response efficiency of elderly care services^[2].

3.2.2. Development of artificial intelligence in health early warning systems

The application of AI technology in the field of smart elderly care is mainly reflected in health risk early warning and decision support. Based on machine learning and deep learning algorithms, AI systems can analyze massive health data from IoT devices, identify abnormal patterns, and predict potential health risks^[19,20]. For example, by analyzing the daily activity patterns and physiological parameter changes of the elderly, AI systems can provide early warnings for emergencies such as fall risks and acute episodes of chronic diseases^[19]. During the COVID-19 pandemic, AI technology also demonstrated its potential in epidemiological modeling and drug development, and these experiences have provided new ideas for addressing the health challenges of an aging society^[21].

3.2.3. Personalized elderly care service models supported by big data

Big data technology provides key support for building personalized elderly care service models. By integrating multi-source data from IoT devices, medical records, and social activities, big data analytics can deeply understand the unique needs and preferences of each elderly individual^[4,22]. This data-driven approach enables service providers to design precise intervention plans, such as customized health management plans, social activity recommendations, and medication reminders^[22]. Big data technology can help address the growing care demands of the elderly with chronic diseases^[4].

4. Background and effectiveness of smart elderly care applications

4.1. Impact of population aging

4.1.1. The impact on the elderly care service system

Population aging has had a profound structural impact on the elderly care service system. Firstly, the continuous weakening of family-based elderly care functions has become a widespread phenomenon. 80% of China's provinces have integrated the combination of medical care and elderly care into basic public health service projects^[23], reflecting the reality that traditional family care models are difficult to sustain.

Secondly, the special needs of the elderly population with multimorbidity pose challenges to service provision. Research indicates that the elderly often suffer from multiple chronic diseases simultaneously, with atypical clinical manifestations^[24], which requires the elderly care service system to possess interdisciplinary comprehensive care capabilities.

Thirdly, the shortage of professional caregivers is becoming increasingly severe. There is a global shortage of the elderly care workforce^[19]. Although 69.3% of public hospitals at or above the secondary level in China have established geriatrics departments^[23], the reserve of professional talent remains insufficient.

4.1.2. The impact on the healthcare system

Surge in chronic disease management demand and strain on medical resources: Population aging has led to a significant increase in the burden of non-communicable diseases (NCDs). These multifactorial, long-term chronic

conditions can only be controlled but not cured, requiring continuous medical management ^[25]. Studies show that 43.9% of the population aged 65 and above suffer from two or more long-term health problems, the most common of which include primary cancer (39.6%), hypertension (37.9%), chronic kidney disease (17.4%), and diabetes (15.4%) ^[26]. As physiological functions gradually decline, the elderly are more susceptible to age-related chronic diseases such as Alzheimer's disease, type 2 diabetes, heart failure, and osteoarthritis ^[27]. This rise in the prevalence of chronic diseases directly leads to continuously growing long-term care demands on the healthcare system, causing a strain on resources for outpatient and inpatient services ^[28,29].

Challenges to the comprehensive diagnosis and treatment system for patients with multimorbidity: Multimorbidity has become a primary characteristic of elderly patients, defined as the simultaneous presence of two or more chronic long-term conditions ^[25,30]. Such patients exhibit higher risks of mortality, polypharmacy, rehospitalization, and functional decline ^[31]. Cardiovascular disease, as the main burden on the elderly population, often forms complex comorbidity clusters with other chronic diseases ^[28,32]. The current specialized medical model leads to fragmented diagnosis and treatment for patients with multimorbidity, failing to meet their comprehensive medical needs ^[33]. It is particularly noteworthy that the incidence of chronic pain exceeds 50% among patients with multimorbidity, while the choice of analgesic drugs faces the dilemma of increased polypharmacy risks ^[34]. This complex situation requires the medical service system to shift from a single-disease management model to a diagnosis and treatment paradigm of comprehensive assessment and holistic intervention ^[35,36].

Disconnect between long-term care and acute medical care: There is a significant service gap between the long-term care needs brought about by population aging and the existing acute medical care system ^[37]. Elderly patients often face "post-discharge syndrome" after acute treatment, including problems such as deterioration of functional status and increased risk of rehospitalization ^[31]. Long-term follow-up studies of heart transplant recipients indicate that the state of multimorbidity and socioeconomic vulnerability significantly influence subsequent patterns of healthcare utilization ^[38]. The current healthcare system lacks effective referral mechanisms to connect acute-phase treatment with community-based long-term care services, resulting in difficulties for elderly patients, especially frail older adults, in accessing continuous medical services ^[35,37]. This disconnect is particularly evident in diseases requiring long-term management, such as chronic kidney disease, where the hospitalization rate for patients with kidney disease and multimorbidity is significantly higher than for those with a single disease ^[39].

4.2. Alleviation of pressure on the healthcare system and elderly care service system through smart elderly care

4.2.1. Alleviation of pressure on the healthcare system

Through the review and analysis of existing literature, we can clearly see that smart elderly care, as a new model of elderly care service deeply integrated with modern information technologies such as the Internet of Things, big data, and artificial intelligence, is influencing the form and core of the healthcare system with unprecedented depth and breadth. Its impact is not a single-dimensional technological overlay but rather a systematic transformation involving service models, resource allocation, system efficiency, and core values ^[40].

Firstly, the most direct impact of smart elderly care lies in promoting a paradigm shift in medical services from being "disease-centered" to "health-centered." The traditional healthcare system primarily plays the role of a "fire brigade," passively responding to sudden health issues of the elderly. In contrast, smart elderly care, through terminals such as wearable devices and smart home sensors, achieves continuous and imperceptible monitoring of the elderly's physiological indicators, daily behaviors, and home environment. This dynamic data flow enables

refined management of chronic diseases, early warning of disease risks, and immediate response to accidental events such as falls. It realizes a shift from “treatment” to “prevention and management”^[40]. The focus of medical services is shifted forward, extending from in-hospital treatment to out-of-hospital prevention, early warning, and early intervention, effectively reducing the incidence of acute events and alleviating pressure on emergency departments and inpatient services. It strengthens the continuity and whole-process management of medical services. This service model helps improve the health management level of the elderly and reduces the long-term burden on the healthcare system.

Secondly, smart elderly care significantly optimizes the efficiency of medical resource allocation, alleviating systemic pressure. Faced with increasingly severe aging challenges, medical resources, especially high-quality physician resources, are particularly scarce. Smart elderly care platforms, through functions such as remote consultations, online prescriptions, and medication reminders, transfer a portion of routine and follow-up medical services online. This breaks temporal and spatial constraints, reduces unnecessary travel for the elderly, and also liberates some of the productivity of physicians. Simultaneously, intelligent assisted diagnosis systems can help primary care physicians improve their diagnosis and treatment levels, promoting the implementation of tiered medical systems. From a macro perspective, this helps concentrate limited offline medical resources on handling more complex and critical illnesses, thereby increasing the operational efficiency of the entire system^[41].

Furthermore, smart elderly care also promotes the construction of a multi-agent collaborative medical service ecosystem. Smart elderly care devices act as hubs connecting elderly patients, family members, medical institutions, and technology providers, facilitating information sharing and process coordination. The participation of multiple forces, including the government, communities, hospitals, and enterprises, jointly promotes the deep integration of smart elderly care and medical services, forming a more efficient and synergistic service system. This not only enhances the efficiency and quality of medical services but also provides new pathways and possibilities for addressing the medical challenges of an aging society.

4.2.2. Alleviation of pressure on the elderly care system

Alleviating human resource shortages: Smart technology effectively alleviates human resource shortages in elderly care services through various means. Intelligent robots can assume multiple roles, such as rehabilitation therapists and emotional supporters^[6]. Nursing robots developed in Japan are already capable of performing 30% of basic care tasks^[18]. IoT systems enable remote health monitoring, allowing a single caregiver to simultaneously monitor multiple elderly individuals^[7]. The CART sensor platform tracks the activity status of the elderly in real-time through motion sensors^[42], significantly reducing the frequency of manual checks. Innovative devices such as self-powered sensors^[43] reduce the reliance on human resources for traditional monitoring, and the intelligent AF application significantly improves medication adherence among elderly patients with atrial fibrillation^[44].

Increasing service efficiency: Firstly, smart home systems can predict the behavior patterns of the elderly and provide advanced prompts for key activities such as medication intake^[45]. The 5G smart emergency platform shortens pre-hospital emergency response time by 40%^[46]. Secondly, artificial intelligence algorithms achieve personalized service matching; the SMART system automatically generates care plans based on sensor data^[47], increasing daily care efficiency by 25%. Thirdly, digital twin technology optimizes resource allocation; China’s “9073” model has increased the coverage rate of community elderly care services to 63% through smart platforms^[4]. It is noteworthy that voice interactive devices reduce the difficulty of technology use by 60%^[6], and studies from Israel show that simplified operation interfaces can increase technology acceptance among the elderly by

three times^[48].

5. Existing problems and challenges

5.1. Technical standards and system compatibility issues

The promotion of smart elderly care faces significant challenges related to technical standards and system compatibility. Multiple demonstration projects employ different technical architectures and data standards, making effective data sharing and functional integration between systems difficult to achieve^[49]. Particularly in cross-regional pilot projects, the lack of uniform data formats for IoT devices and health monitoring terminals severely impacts the aggregation and analysis of health data across the city^[19]. Furthermore, the absence of unified interoperability protocols for various smart elderly care devices makes it difficult for systems developed by different manufacturers to work together. This not only increases operation and maintenance costs but also limits the large-scale application of smart elderly care services^[50]. These issues are particularly prominent when Shanghai promotes the coordinated development of smart elderly care in the Yangtze River Delta region^[1].

5.2. Privacy protection and data security risks

Privacy protection and data security are core challenges in the development of smart elderly care in Shanghai. The vast amount of health data collected by smart monitoring devices involves sensitive personal information of the elderly, but current data protection measures still lag behind international standards such as GDPR^[51]. Some health monitoring APPs exhibit excessive data collection, gathering non-essential data such as location information and social relationships^[52]. More seriously, the encryption levels for data transmission and storage in some systems are insufficient, posing risks of malicious attacks^[53]. The elderly, as a digitally vulnerable group, often lack understanding of privacy settings, making them more susceptible to privacy breaches^[54]. Although Shanghai has introduced local data protection regulations, supervision and technical safeguards still need strengthening at the implementation level^[55].

5.3. Service recipient acceptance and the digital divide

Shanghai's smart elderly care initiatives face a significant intergenerational digital divide. Surveys indicate that only about 30% of the elderly aged 75 and above can proficiently use smart elderly care devices^[56]. Elderly groups in rural areas with poorer economic conditions and those living alone show more pronounced barriers to technology adaptation^[57]. This digital divide is manifested not only at the level of device operation but also in psychological acceptance—a considerable proportion of the elderly resist smart monitoring, viewing these technologies as an intrusion into their personal living space^[58]. Additionally, common age-related problems such as visual impairment and declining cognitive function further exacerbate the difficulty of using technology^[59]. It is noteworthy that a significant correlation exists between the digital divide and health inequality; the daily living ability scores of the elderly who cannot use smart health devices are significantly lower^[60]. If this phenomenon of “technology exclusion” is not effectively resolved, it may limit the coverage of smart elderly care services and instead exacerbate health inequalities among the elderly population^[60].

5.4. Lagging training system for professional caregivers

The global aging trend poses severe challenges to the supply of professional care personnel. Although 69.3% of public hospitals in China at or above the secondary level have established geriatrics departments, the shortage

of professional personnel remains as high as 48%^[61]. Cases from Sweden show that even in relatively resource-sufficient developed countries, the field of elderly care faces dual pressures of human resource shortages and insufficient funding^[62]. The existing training system has three prominent problems: first, the insufficient provision of interdisciplinary curricula makes it difficult to meet the comprehensive nursing needs of patients with multimorbidity; second, imperfect continuing education mechanisms result in limited proficiency among medical staff in emerging elderly-appropriate technologies^[54]; third, unclear career development paths lead to insufficient job attractiveness^[63]. This lag in talent cultivation was particularly evident during public health crises such as the COVID-19 pandemic, directly impacting the emergency response capacity of medical-elderly care integrated services^[64].

6. Predictions and suggestions for future development directions

6.1. Policy support and optimization of funding investment

The development of smart elderly care in Shanghai requires continuous policy support and optimized funding investment. The Chinese government, from the central to local levels, has already formulated a series of policies to support the development of the smart elderly care service industry^[4]. We believe that the Shanghai municipal government can further increase financial investment, supporting technological innovation and service model innovation in smart elderly care through methods such as establishing special funds. Simultaneously, the government can optimize the efficiency of fund utilization, focusing support on smart elderly care projects with demonstrative effects^[4]. It could also learn from international experience by establishing a diversified investment and financing mechanism guided by the government and operated by the market, to attract social capital participation in the development of the smart elderly care industry^[4]. Furthermore, policy coordination should be strengthened to ensure the coordinated implementation of policies related to smart elderly care with those in healthcare, social security, and other fields^[4].

6.2. Paths for interdisciplinary technology integration and innovation

The future development of smart elderly care requires strengthened interdisciplinary technology integration and innovation. Research indicates that under the combined effect of technologies such as artificial intelligence, the Internet of Things, and edge intelligence, a “1+1>2” effect can be achieved, thereby meeting the diverse needs of elderly care^[19].

We believe that Shanghai can, in the future, promote the integration of artificial intelligence with remote sensors and robotics technology to develop more intelligent health monitoring systems^[65] or actively integrate big data, the Internet of Things, and nursing robot technology to construct a networked smart elderly care model^[18]. At the same time, industry-academia-research collaboration should be enhanced to establish interdisciplinary innovation platforms and promote technological collaborative innovation^[66].

7. Conclusion and outlook

The global aging trend has formed a multi-level pressure transmission mechanism affecting both the elderly care service system and the healthcare system. Regarding the healthcare system, population aging directly leads to a surge in chronic disease management demands, with the phenomenon of multimorbidity significantly increasing among the population aged 65 and above^[67,68], creating risks of medical resource strain. Research indicates that

the incidence of pressure injuries among elderly patients during hospitalization is as high as 14.3%, significantly higher than in other age groups ^[69]; these special medical needs further increase the system burden. At the physiological level, aging leads to thickening of the extracellular matrix and reduced shear stiffness ^[70,71], affecting tissue mechanical properties. These microscopic changes manifest at the macroscopic system level as clinical characteristics and medical needs specific to the elderly ^[70]. The elderly care service system faces dual pressures of weakened family-based elderly care functions and a shortage of professional caregivers ^[72]. The traditional family care model struggles to meet the growing long-term care demands, forcing community services and institutional care to undergo structural expansion.

China faces the most severe aging challenges globally, with the proportion of the population aged 65 and above projected to reach 26.1% by 2050 ^[72]. This necessitates the establishment of a development path suited to the national context.

The experience of Shanghai provides important strategic insights for China in addressing the challenges of population aging. Firstly, China needs to establish nationwide technical standards and system compatibility specifications for smart elderly care to resolve the current issue of technological fragmentation ^[58]. Secondly, attention should be paid to the digital divide by designing more intuitive, user-centered intelligent technology solutions to enhance acceptance among the elderly population ^[73]. Thirdly, drawing on the Shanghai model, the government-guided, market-led, and industry-academia-research collaborative development path for smart elderly care can be promoted nationwide.

Finally, we believe that China needs to establish an interdisciplinary research system for smart elderly care, while integrating technologies such as artificial intelligence, the Internet of Things, and edge intelligence to improve the quality and safety of long-term care ^[19]. As population aging accelerates, accelerating the construction of a nationwide smart elderly care ecosystem will become an important strategic measure for China to cope with the challenges of an aging society ^[2,18].

Disclosure statement

The authors declare no conflict of interest.

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