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NARRATIVE REVIEW 1

Enhancing the wellbeing of older adults through domestic automation: A Preventive Assistive Monitoring and Alert System (PAM-AS) Approach

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Abstract

With the enveloping problem of social isolation and vulnerability among the elderly, it is crucial that technology be integrated into the environment surrounding them. This increases the likelihood of automating the domestic niches of older adults. Domestic automation, also referred to as domotics, is the centralised control of the electrical appliances, flooring, and energy systems for convenience and comfort.

Compared with concurrent demographic transitions and reportedly high social isolation among the elderly population, there is a paucity of structured approaches to developing smart homes. There is no literature addressing all domains of care for older adults living alone. This review aims to contribute to the development of a self-sufficient domestic automation model and delineate existing barriers to establishing domotics as a care plan.

Keywords: housing for the elderly, automation, social isolation, remote patient monitoring, self-help devices, telemedicine

Introduction

Social isolation [1-4] is associated with an increased risk of dementia, cardiovascular diseases, and other serious medical conditions. "Social isolation is the objective physical separation from other people, and loneliness is the subjective distressed feeling of being alone or separated [1,2]." While both terms are distinct, they are similar in causing a toll on the psychological grounds of the elderly, making them more vulnerable to morbid conditions.

The Integrated Care for Older People Approach (ICOPE) [5] provides a holistic idea of intrinsic capacity as the composite of all the physical and mental capacities that an individual can draw on. However, the concept of healthy ageing centres on functional ability [6]. The restoration of functional ability in socially isolated older individuals becomes pivotal. Functional ability [5], as elaborated by WHO, is the health-related attributes that enable people to be and to do what they have reason to value; it is made up of the intrinsic capacity of the individual, relevant environmental characteristics, and the interactions between the individual and these characteristics.

The possible plan of restoration of functional ability shall be aligned with the domains of intrinsic capacity [7]; the progressive deficits in individual domains serve as areas for healthcare professionals to cover.

The domains of intrinsic capacity, such as cognition, locomotion, vitality, sensory, and psychosocial, can be elaborated for the prevalent geriatric giants. Bernard Isaacs, in 1965, coined the term "geriatric giants [8]."

It encompassed immobility, instability, incontinence, and impaired intellect/memory. Modern geriatrics has evolved further to include frailty, sarcopenia, the anorexia of ageing, and cognitive impairment [9]. The relationship between loss of intrinsic capacity and the gravity of geriatric giants is shown in Figure 1.

Social isolation is an emerging geriatric giant [10]. This giant increases the debilitating power of already existing giants in a multitude of domains.

This underscores the importance of revitalising the surroundings with the core assistance of technology. This would form a bridge between healthcare providers and the elderly through technology. However, there is a versatile spectrum of taxonomies in existing literature related to Health 2.0, as highlighted in Figure 2.

A possible approach of upgrading and vitalising the environment is domestic automation, also known as domotics. Getting a surface-level idea of domotics, one may say it is a centralised network connected to a central smart home hub that acts as a gateway. The user interface is designed to make the user-machine interface easy, emphasising the role of ergonomics and psychology during model development as shown in Figure 3.

The smart environment should be adaptive, personalised, predictive, and, above all, non-intrusive. This would expand the user base to people with disabilities or severe morbid conditions.

In this review, we elaborate on possible combinations of available technologies for constructing models, namely Preventive Assistive Monitoring-Alert System Models (PAM-AS models). PAM-AS models are described in relation to the domains of intrinsic capacity for all the geriatric giants. These models are to be extrapolated to the domestic settings to restore functional ability with the concurrence of social isolation.

Rationale

Domotics would provide a viable option for older adults and people with disabilities who would prefer to stay in the comfort of their homes rather than move to a healthcare facility. It would complement the traditional healthcare setting.

As there is an increased demand on the healthcare system from a growing elderly population and a shortage of healthcare providers, this would maintain their independence and safety, also saving the costs and anxiety of moving to a healthcare facility. Additionally, smart homes would provide opportunities for independence by offering emergency assistance systems, security features, fall-prevention measures, automated timers, and alerts, enabling family members to monitor via an internet connection. It would undeniably bridge the gap between patient demand and healthcare accessibility.

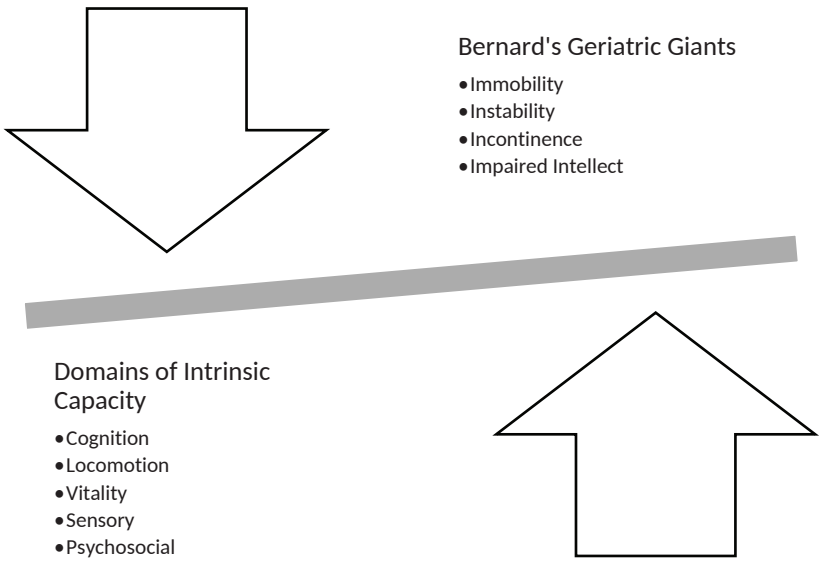


Figure 1. Geriatric giants' decline in domains of intrinsic capacity.

Electronic health (eHealth)	Mobile health (mHealth)	Ubiquitous health (uHealth)	IoT-powered healthcare deliivery systems
ML-powered healthcare delivery sytems	AI integrated Healthcare	Big data analytics	Medical Assistive and Preventive Gamification
Telemedicine	Wearable Sensor networks	Iot-ML integrated healthcare delivery system	Emergency Assistance Systems
Blockchain Technology	Sensor-IoT-AI-Blockchain Integartion	Ambient Assisted Living	Augmented (AR) and Extended Reality (XR)

Figure 2. Common taxonomy used for technology in Health 2.0.

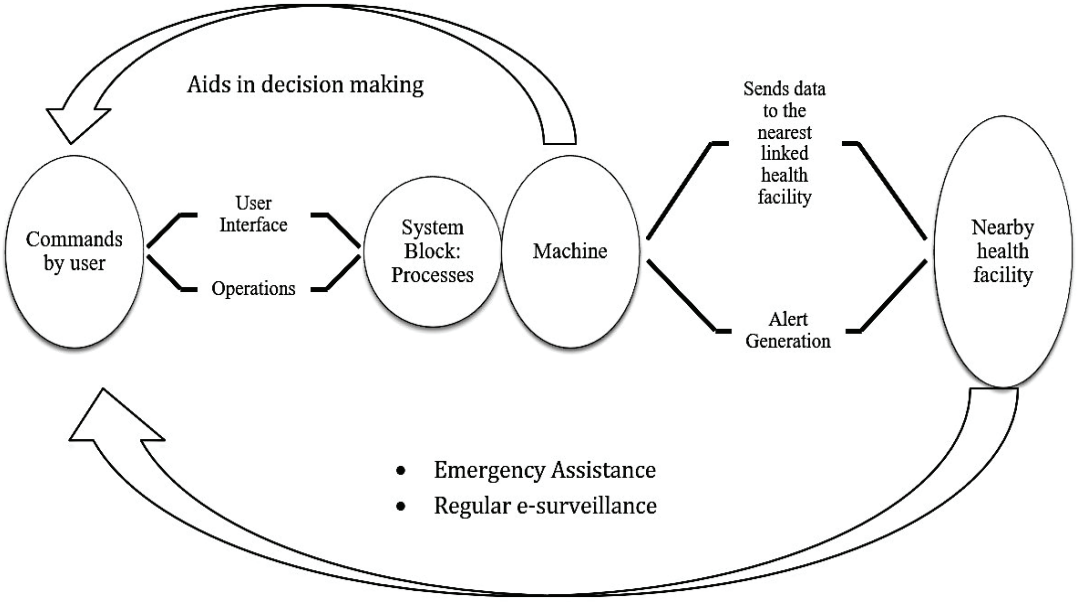


Figure 3. Link between user, machine, and health facility.

Methodology

This review was conducted to explore existing research and developments in domestic automation for elderly care, with a focus on the development of preventive assistive monitoring and alert systems (PAMAS). The review aimed to synthesise available evidence, identify technological approaches, and highlight challenges and gaps in integrating smart home solutions for elderly individuals living independently.

Studies that addressed domestic automation or smart home technologies designed specifically for older adults were included. Studies focusing on preventive monitoring, safety alerts, or emergency response mechanisms were included to extract viable information for the development of PAM-AS models. The articles published in peer-reviewed journals, review papers, conference proceedings, and reports from credible organisations in English between 2010 and 2025 were eligible.

The studies that focused exclusively on clinical care settings such as hospitals or long-term care facilities, or hospice care, with any involvement of a caregiver were excluded. The other reason for ineligibility was that the research did not specifically target elderly populations or

those living alone, or that articles lacked substantive data or conceptual frameworks, such as opinion pieces. Although this review did not employ a formal quality appraisal tool, it emphasised the inclusion of peer-reviewed research and validated frameworks to ensure reliability.

Deficits of existing smart home measures

There is a lack of standardised security measures in home automation, with no defining guidelines surrounding the setup and security measures.

There is an exponential increase in the population of low- and middle-income countries (LMICs). This rapid population growth strains both national and family budgets, causing vulnerable or dependent groups to suffer disproportionately and to be at the periphery of attention. Subsequently, due to the high initial cost of ownership and management, the elderly population in LMICs is forced to extrapolate the existing, costly and centralised automation models.

People with social isolation are adversely affected in the context of different aspects of functional status, causing decreased adaptation to learn the systems. Also, the existing models reflect the inflexibility of interconnected devices, confusing and reducing the compliance of the older adults with the models. Thus, many of the interfaces designed for home automation are not intended to consider functional limitations associated with age. The flexibility of the systems should coordinate with the decline of functional ability with age.

The biggest concern expressed by potential users of smart home technology is the fear of a lack of human responders or the possible replacement of human caregivers by technology. This fear, which is associated with the use of technology and artificial intelligence, despite age, is prominent, resulting in deliberate restrictive exposure to the technology modalities.

Unsupervised data acquisition, data stream mining, pervasive confidentiality and privacy concerns, and paranoia impede the expansion of domotics into homes, per se. The more functions, the more the complexity, and the poorer the manageability. Also, it is seen that there is a deprecation of older devices without backward compatibility. All these problems have created a quandary in finding a feasible and adaptive way to assist the elderly.

Applications of automated homes or setups for older adults should be included as components while designing a model.

In the kitchen, a smart kitchen features a refrigerator inventory, premade cooking programs, cooking surveillance, and more. Lighting control system: a "smart" network that incorporates communication between various lighting system inputs and outputs, using one or more central computing devices. Heating, ventilation, and air conditioning (HVAC): It is possible to remotely control of all home energy monitors over the internet via a simple, user-friendly interface.

Other essential components of the model may include leak detection, smoke and CO detectors, laundry-folding machines, self-making beds, and Indoor positioning systems (IPS). Occupancy-aware control system: It is possible to sense the occupancy of the home using a smart meter and environmental sensors like CO2 sensors, which can be integrated into the building automation system to trigger automatic responses.

Air quality control (inside and outside). For example, the Air Quality Egg is used by people at home to monitor the air quality and pollution level in the city and create a map of the pollution. For Home Security, a household security system integrated with a home automation system can provide additional services such as remote surveillance of security cameras over the Internet, or access control and central locking of all doors and windows. For pet and baby care, tracking pets and babies' movements, and controlling pet access rights.

Appliance control and integration with the smart grid and a smart meter, taking advantage, for instance, of high solar panel output in the middle of the day to run washing machines. Components that may be highlighted are the lighting control system, occupancy aware control system, appliance control, leak detection, voice control, gait monitoring, indoor positioning systems, and others.

Some of the monitoring or safety devices that can be installed in a home include lighting and motion sensors, environmental controls, video cameras, automated timers, emergency assistance systems, and alerts.

Concept of automation

Two network systems might be used for the automation, which are embedded health systems and private health networks. Embedded health systems integrate sensors and microprocessors into appliances, furniture, and clothing to collect data that is analysed to diagnose diseases and identify risk patterns. Private health networks implement wireless technology to connect portable devices and store data in a household health database.

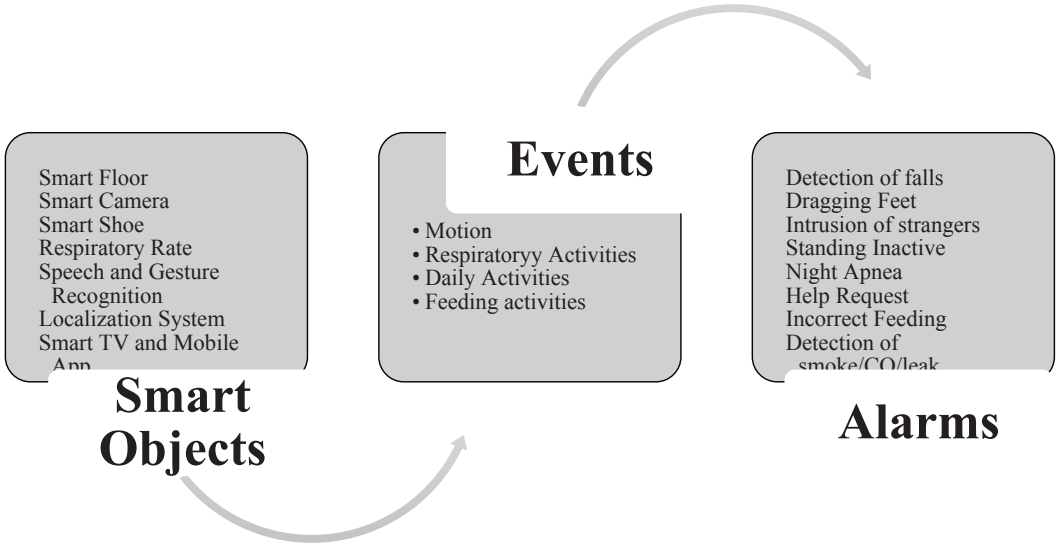
Smart homes' architecture is composed of hardware with sensors for physiological monitoring called wearables and sensors for environmental monitoring called ambients, which include a thermostat, green switch- IR, ultrasound, electrical consumption meters, and light status. The software component consists of the integrating frameworks, which offer a centralised service-oriented architecture with loosely coupled services. In contrast to sensors, actuators are the devices that affect the surroundings. They can be

classified into three types on the basis of their operation: electrical, pneumatic, and hydraulic. A possible link of smart objects (sensors: wearables, ambients, actuators), events, and alarms is provided in Figure 4.

PAM-AS model for geriatric giants

A PAM-AS model is a domestic automation model providing the possible choices of technological tools conforming to care in the form of prevention, assistance, and monitoring, augmented with alert systems. PAM-AS model encompasses the spectrum of all geriatric giants and the multitude of domains of intrinsic capacity, as displayed in (Table 2).

An interactive layout of a possible PAM-AS model is depicted in Figure 5.



	Functions	Components	Parameters	Qualities
Smart Floors	• Mechanical support • Adequate response to the needs of heating • Damping of mechanical noise • Satisfaction of aesthetic requirements of the environment	• Infrared motion sensors • Ultrasonic devices • Camera system • Image processing	• Localization • Tracking • Fall detection • Alert generation	• Works in a noisy environment • Simple tile-based smart flooring • Not affected by the quality of illumination and chromaticity of the clothes of the user.

Figure 4. Link between smart objects, events, and alarms.

Components of Domotics:

Gesture Analysis Systems	• Preventive alarms • Alert generations • Mood tracking with feature extraction from images.	• Hand gestures and skin modelling • Parametric skin distribution modeling • Non-parametric skin distribution modeling • Analysis • Recognition	• Localization • Tracking of range of motion • Alert generation	• Works in a noisy environment • Not affected by the quality of illumination and chromaticity of the clothes of the user. • Detects the contemporary range of motion
Health-related mobile applications	• Information delivery and reminders • Guide in weight • reduction • Health record • Fall prevention • Memory assistance • Early detection • Virtual training guide	• Home BP monitoring • Physical activity monitoring • Sodium intake self-monitoring • Physical activity and sodium intake goal setting • Awareness alerts through push notification and in-app messaging • Medication reminders.	• Telemonitoring • Physiological parameters • Environmental parameters • Meal frequency • Drug compliance • Location tracking	• Simple user interface
Integrated sensor networks	• Physiological data acquisitions • Controlling the home automation	• Devices to acquire and monitor the physiological parameters of the user • Sensors to acquire and monitor the user's domestic environment • A gateway and local storage device to collect the data and signals • A smart device to interact with the user	• Physiological parameters • Environmental parameters	• A simplified and accessible user interface
Telehealth	• Patient-provider consultation • Electronic delivery of medication instructions and general health information	• Video-conferencing • Telemonitoring	• Compliance with treatment • Current status of disease	• User-friendly

The following components of domotics are elaborated in Table 1.

- Telehealth
- Emergency assistance systems:
    - Falling;
    - irregular heartbeat;
    - fire;
    - flooding;
    - intrusion of strangers;
    - distress call;
    - excessive humidity in the environment;
    - malfunctioning communications systems;
    - therapy-mandated drug delivery;
    - anomalies in the habits of the assisted;

- Reminder systems
- Medication dispensing and spoon-feeding
- Home robotics
- Health applications
- Smart floor
- Gesture analysis systems

Table 2. PAM-AS model for Geriatric giants

DOMAINS OF IC	PREVENTIVE	ASSISTIVE	MONITORING	ALERT SYSTEMS
COGNITION	• MHealth apps for cognitive therapy • Voice-activated safety devices • Orientation aids • Dementia clocks	• Cognitive exercises • Cognitive rehabilitation • Simulated Presence therapy • Cognitive recreation • Tele-reminiscence therapy	• Gesture analysis systems • Bed sensors • Activity trackers	• GPS trackers
LOCOMOTION	• Wearable fall prevention device • Wearables and ambient sensors • Frequent alarms to sit and stand	Emergency assistance system for falls (second and third generation)	• Gait pattern analysis • Smart floor integrated with cameras • Smart shoes with sensors • One gait cycle data monitoring • Body motion	• Falls alert • Dragging feet alert • Standing inactive
VITALITY	• Regular hydration and meal alarms • Qualitative personalized meal plan using AI	• Meal reminder systems • Therapy-mandated drug delivery • Spoon feeding • Medication dispensing and spoon feeding	• Blood glucose monitoring • Adverse drug event monitoring	

SENSORY	• AI-embedded refractive glasses	• Command-based navigation in the dark	• Speech and gesture recognition	
PSYCHOSOCIAL	• Gamification • Voice Assistants • Telemedicine	• Telehealth • Distress call • Video calls with relatives • Extended Reality (XR) • Care robots • Robotic pets	• Mood monitoring with speech	
MULTIFACTORIAL	• Heating, ventilation, and air conditioning (HVAC) • Household security system • Hydraulic actuators	• Home robotics for household chores • Smart Kitchen • Laundry folding machines • Self-making beds • Indoor positioning systems • Controlled irrigation of the garden	• Wearable sensor networks • Electrolyte monitoring sensors • Heart rate monitoring • Blood pressure monitoring • Sensors to monitor temperature and humidity • Cooking surveillance • Occupancy-aware control systems • Remote surveillance of security cameras	• Night apnea alert • Intrusion of strangers' alert • Fire alert • Leak and smoke detection alert • Carbon Monoxide (CO) detection alert

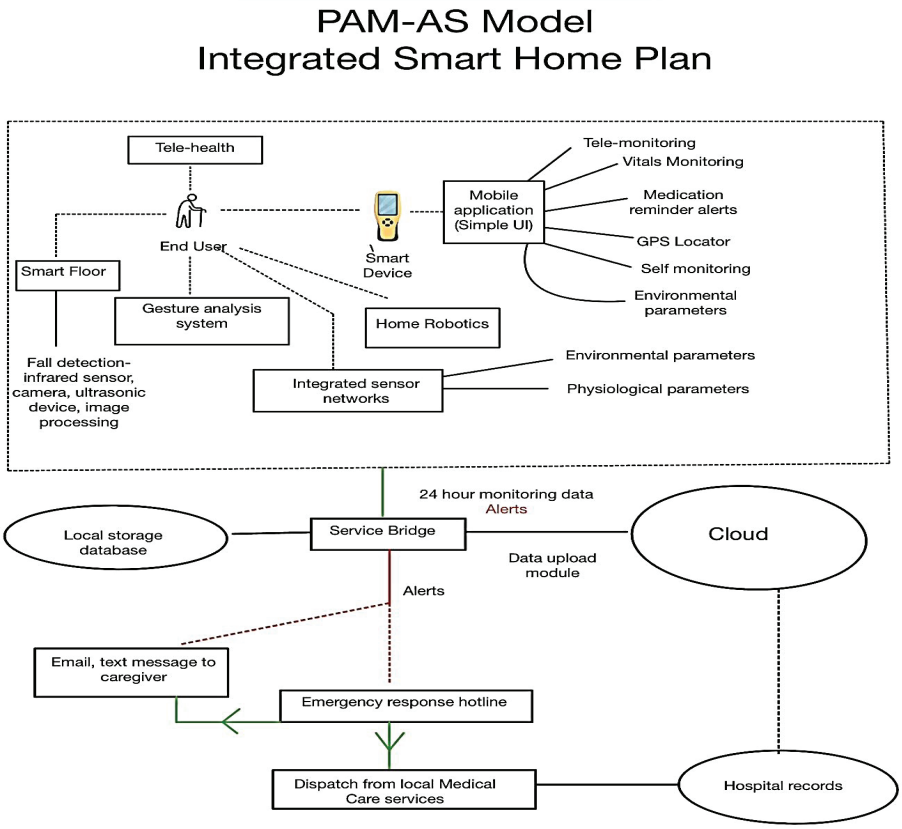


Figure 5. PAM-AS model integrated Smart home plan.

Conclusions

With the ongoing pandemic of social isolation and loneliness, automated homes are one such solution to decrease the massively increasing toll in terms of psychological burden and demand for assistance. Although there are many aspects and components to consider while developing a feasible and acceptable model, focused research on this subject is underscored.

Because LMICs face geographical, financial, and human resource constraints, and given existing infrastructure deficits, the adoption of such models is difficult. The main implication of this approach is to incentivise the development of such models at feasible costs at the macro or policy-making level, particularly in LMICs. Nevertheless, this can only be followed by the formal acknowledgement of the requirement of domotics models and judicious resource allocation to geriatric care in any country. This can begin with a small step of funding pilot deployments into chronic care models. Furthermore, to make this possible in any LMIC, public-private partnerships would enable low-cost, accessible models without complex economic barriers. Under the regulated frameworks mandating the privacy protections and interoperability standards by the government, public-private integrations would be a holistic plan. These frameworks can be integrated with an incremental rollout with initial basic alert functions and gradual addition of complex systems.

Implications

Compared to existing frameworks, the Preventive Assistive Monitoring and Alert System (PAM-AS) approach aligns closely with and extends several established models. For instance, smart home healthcare frameworks integrate home automation with health monitoring, promoting patient engagement and chronic disease management through in-home sensors and connectivity.

In effect, PAM-AS can be seen as an instantiation of Ambient Assisted Living that integrates machine intelligence for early risk detection. Existing literature suggests that such intelligence is needed: the next step in AAL is to use these data while taking the state of residents' states, the environments, and their privacy into account. Thus, PAM-AS complements IoT-based smart home models by prioritising real-time alerting: it broadens traditional monitoring systems (which often focus on data logging) into active prevention tools.

Nonetheless, like other models, PAM-AS will need to address interoperability, data management, and the human factors emphasised by scholars (e.g., the integration of medical and psychological expertise in design). In short, PAM-AS embodies and extends the principles of AAL and smart home healthcare, combining comprehensive sensing networks with early-warning logic to support older adults' autonomy.

Limitations

Only English-language research released between 2010 and 2025 was considered in the review. This limitation may have led to the omission of pertinent studies published outside of the allotted time frame or in languages other than English.

There was no official evaluation of methodological quality or bias risk, which would have affected the interpretation of the results and their reliability across all included studies. There was no formal critical appraisal of the studies included. A substantial amount of grey literature was included in the studies, which may indicate heterogeneity among the sources. There is no data on the long-term viability, safety, and efficacy of many of the technologies and automation models included because they are still in the early phases of development or deployment.

Despite being recognised, issues such as cost, infrastructure, and digital literacy–particularly in low- and middle-income countries–were not thoroughly examined or addressed in the investigation.

References

1. Cacioppo S, Capitanio JP, Cacioppo JT. Toward a neurology of loneliness. *Psychol Bull*. 2014;**140**(6):1464–504. DOI: 10.1037/a0037618
2. Xia N, Li H. Loneliness, social isolation, and cardiovascular health. *Antioxid Redox Signal*. 2018;**28**(9):837–51. DOI:10.1089/ars.2017.7312
3. Albasheer O, Abdelwahab SI, Zaino MR, et al. The impact of social isolation and loneliness on cardiovascular disease risk factors: a systematic review, meta-analysis, and bibliometric investigation. *Sci Rep*. 2024;**14**(1):12871. DOI:10.1038/s41598-024-63528-4
4. Portacolone E, Perissinotto CM, Yeh J, et al. "I feel trapped": The tension between personal and structural factors of social isolation and the desire for social integration among older residents of a high-crime neighbourhood. *Gerontologist*. 2018;**58**(1):79–88.
5. World Health Organisation. Integrated care for older people (ICOPE): guidance for person-centred assessment and pathways in primary care. *Geneva*: World Health Organisation; 2019.
6. Rudnicka E, Napierała P, Podfigurna A, Męczekalski B, Smolarczyk R, Grymowicz M. The World Health Organisation's approach to healthy ageing. *Maturitas.* 2020; **139**:6–11. DOI:10.1016/j.maturitas.2020.05.018
7. Cesari M, Araujo de Carvalho I, Amuthavalli Thiyagarajan J, et al. Evidence for the domains supporting the construct of intrinsic capacity. *J Gerontol A Biol Sci Med Sci.* 2018;**73**(12):1653–60. DOI: 10.1093/gerona/gly011

8. Morley JE. A brief history of geriatrics. *J Gerontol A Biol Sci Med Sci.* 2004;**59**(11):1132–52. DOI:10.1093/gerona/59.11.1132
9. Morley JE. The new geriatric giants. Clin Geriatr Med. 2017;**33**(3):xi–xii. DOI:10.1016/j.cger.2017.05.001
10. Freedman A, Nicolle J. Social isolation and loneliness: the new geriatric giants—approach for primary care. *Can Fam Physician*. 2020;**66**(3):176–82.