International Journal of Innovative Technologies in Social Science

e-ISSN: 2544-9435

Operating Publisher
SciFormat Publishing Inc.
ISNI: 0000 0005 1449 8214

2734 17 Avenue SW,
Calgary, Alberta, T3E0A7,
Canada
+15878858911
editorial-office@sciformat.ca

ARTICLE TITLE	SMART HOME SENSORS FOR AMBIENT ASSISTED LIVING IN THE GERIATRIC POPULATION: CLINICAL EFFICACY, ETHICAL CONSIDERATIONS, AND SOCIOECONOMIC DISPARITIES
DOI	https://doi.org/10.31435/ijitss.3(51).2026.6512
RECEIVED	02 June 2026
ACCEPTED	07 September 2026
PUBLISHED	10 September 2026
LICENSE	The article is licensed under a **Creative Commons Attribution 4.0 International License.**

SMART HOME SENSORS FOR AMBIENT ASSISTED LIVING IN THE GERIATRIC POPULATION: CLINICAL EFFICACY, ETHICAL CONSIDERATIONS, AND SOCIOECONOMIC DISPARITIES

Antoni Kantor *(Corresponding Author, Email: kantor.antoni@gmail.com)*
Medical University of Silesia, Poniatowskiego 15, 40-055 Katowice, Poland
ORCID ID: 0009-0003-7908-6440

Kacper Raputa
Medical University of Silesia, Poniatowskiego 15, 40-055 Katowice, Poland
ORCID ID: 0009-0004-6709-5427

Jakub Gościński
Medical University of Silesia, Poniatowskiego 15, 40-055 Katowice, Poland
ORCID ID: 0009-0008-6121-5941

Aniela Kupiec
Medical University of Silesia, Poniatowskiego 15, 40-055 Katowice, Poland
ORCID ID: 0009-0000-4027-5066

Bartosz Kus
Medical University of Silesia, Poniatowskiego 15, 40-055 Katowice, Poland
ORCID ID: 0009-0004-1062-8974

Michał Tutaj
Provincial Specialist Hospital No. 4 in Bytom, Legionów 10, 41-902 Bytom, Poland
ORCID ID: 0009-0003-3190-6243

Igor Kania
Medical University of Silesia, Poniatowskiego 15, 40-055 Katowice, Poland
ORCID ID: 0009-0006-3146-4803

Wiktor Rybicki
Nowodworskie Centrum Medyczne, Miodowa 2, 05-100 Nowy Dwór Mazowiecki, Poland
ORCID ID: 0009-0004-8619-3428

Marta Godyń
Provincial Specialist Hospital No. 4 in Bytom, Legionów 10, 41-902 Bytom, Poland
ORCID ID: 0009-0005-8396-1273

Mateusz Pietrasz
Provincial Specialist Hospital No. 4 in Bytom, Legionów 10, 41-902 Bytom, Poland
ORCID ID: 0009-0007-7272-1981

ABSTRACT

Background: The global demographic shift toward an aging population exacerbates the clinical burden of multi-morbidity, falls, and functional decline, alongside a persistent shortage of geriatric healthcare professionals. Ambient Assisted Living (AAL) technologies utilizing edge-AI passive sensors offer a scalable, unobtrusive approach to continuous remote monitoring.

Objectives: This narrative review aims to synthesize recent clinical data regarding the efficacy of AAL systems in geriatric care while critically evaluating the ethical tensions and socioeconomic barriers impeding equitable adoption.

Methods: A comprehensive synthesis of peer-reviewed literature published between 2020 and 2026 was conducted, focusing on the biomechanical tracking of falls, longitudinal monitoring of Activities of Daily Living (ADLs), dynamic consent, privacy concerns, and digital health equity.

Results: Clinical evidence indicates AAL networks effectively identify early digital biomarkers of cognitive and physiological decline, mitigating injurious falls and reducing 30-day hospital readmissions. However, continuous domestic surveillance introduces significant ethical dilemmas concerning patient autonomy and the medicalization of the home environment. Furthermore, formidable financial constraints, algorithmic bias, and inadequate broadband infrastructure restrict AAL adoption to affluent demographics, exacerbating systemic health disparities.

Conclusions: While AAL technologies present substantial clinical utility for proactive geriatric care, their unchecked commercial deployment risks institutionalizing diagnostic inequalities. Equitable implementation requires formal public health subsidization, equity-by-design algorithmic training, and rigorous bioethical frameworks to balance clinical beneficence with patient privacy.

KEYWORDS

Ambient Assisted Living, Geriatrics, Health Equity, Remote Patient Monitoring, Artificial Intelligence, Bioethics

CITATION

Kantor, A., Raputa, K., Gościński, J., Kupiec, A., Kus, B., Tutaj, M., Kania, I., Rybicki, W., Godyń, M., & Pietrasz, M. (2026). Smart home sensors for ambient assisted living in the geriatric population: Clinical efficacy, ethical considerations, and socioeconomic disparities. *International Journal of Innovative Technologies in Social Science*, 3(51). https://doi.org/10.31435/ijitss.3(51).2026.6512

Introduction

The global demographic landscape is undergoing an unprecedented shift toward an aging population, largely driven by increased life expectancy and declining birth rates. This transition presents significant clinical and systemic challenges, characterized by a rising prevalence of multi-morbidity among community-dwelling older adults. Among the myriad geriatric syndromes exacerbated by multi-morbidity, falls represent a critical public health concern. Falls are a leading cause of injury-related morbidity and mortality in the elderly, often precipitating a rapid trajectory of functional decline, psychological trauma, loss of independence, and subsequent institutionalization [1]. Concurrently, healthcare systems worldwide are facing severe structural strain due to a growing disparity between the escalating demand for long-term care and an acute, persistent shortage of trained geriatric healthcare professionals and informal caregivers. This misalignment underscores an urgent need for scalable, technology-driven interventions that can facilitate safe aging in place while reducing the reliance on direct, continuous human supervision.

In response to this clinical demand, Ambient Assisted Living (AAL) has emerged as a promising technological paradigm. AAL encompasses a broad, integrated ecosystem of embedded smart technologies, communication networks, and software applications designed to proactively support the health, safety, and functional independence of older adults within their residential environments [2]. A critical evolution within the contemporary AAL framework is the transition toward edge-based Artificial Intelligence (edge-AI) coupled with passive environmental sensors. Unlike traditional wearable devices, which require active user compliance, physical dexterity, and regular maintenance, passive sensors operate unobtrusively within the home architecture. These include infrared motion detectors, magnetic contact sensors on doors and cabinets, and ambient light or temperature monitors that do not require direct user interaction [3]. Edge-AI enhances this architecture by processing the continuous, high-volume streams of sensor data locally on the hardware device itself, rather than transmitting raw, sensitive data to centralized cloud servers. This localized computational model minimizes algorithmic latency, enabling real-time anomaly detection, and significantly mitigates inherent data privacy risks.

The clinical efficacy of these smart home sensor networks is increasingly well-documented in the recent scientific literature. By continuously monitoring behavioral patterns, spatial transitions, and indoor movement complexity, edge-AI algorithms can establish individualized baselines for activities of daily living and rapidly identify pathological deviations. Such deviations often serve as early digital biomarkers for subclinical cognitive decline, increasing physical frailty, or acute physiological events such as sudden falls or nighttime wandering [2, 3]. Consequently, AAL systems facilitate proactive, personalized clinical interventions, optimize the remote management of chronic conditions, and provide critical, time-sensitive alerts to caregivers, thereby addressing both the acute and longitudinal care needs of the multi-morbid geriatric population [1].

However, the widespread proliferation of AAL technologies introduces complex ethical dilemmas that must be carefully navigated by clinicians and developers. The continuous surveillance inherent in smart home environments, even when utilizing anonymized passive sensors, raises profound concerns regarding patient autonomy, informed consent, and fundamental human dignity. Older adults frequently experience psychological pressure, anxiety, and a sense of lost agency when subjected to pervasive monitoring, necessitating a rigorous ethical framework that balances clinical safety with the preservation of personal privacy [4]. Furthermore, the commercial deployment of smart home technologies risks exacerbating existing socioeconomic disparities in health equity. The substantial financial burden associated with acquiring, installing, and maintaining AAL infrastructure, coupled with the prerequisite of reliable broadband connectivity, disproportionately excludes low-income and historically marginalized older adults [2].

Therefore, the primary objective of this narrative review is to systematically synthesize recent literature evaluating the clinical efficacy of smart home sensors and AAL frameworks in managing the geriatric population. Concurrently, this review will critically evaluate the ethical constraints and socioeconomic barriers associated with these advanced technologies, aiming to provide a comprehensive, multidimensional analysis of how smart home interventions can be equitably integrated into modern geriatric care models without widening existing disparities in health equity.

Methodology

This narrative review systematically synthesized peer-reviewed literature published between 2020 and 2026 to evaluate the integration of Ambient Assisted Living (AAL) technologies in geriatric care. The methodology focused on extracting clinical, ethical, and socioeconomic data regarding edge-AI passive sensor networks. Specifically, the literature search targeted studies demonstrating the clinical efficacy of these systems in the biomechanical tracking of falls and the longitudinal monitoring of activities of daily living. Concurrently, the review critically analyzed sources addressing the ethical tensions of continuous domestic surveillance, emphasizing dynamic consent and privacy concerns. Finally, articles discussing digital health equity, financial constraints, and algorithmic bias were evaluated to assess the structural barriers preventing the equitable adoption of smart home interventions among marginalized older adults.

Results

1. Clinical Efficacy of Ambient Assisted Living Technologies

The integration of Ambient Assisted Living (AAL) technologies within the geriatric care continuum has demonstrated measurable efficacy across several core clinical domains. Recent systematic evaluations indicate that passive environmental sensors and edge-AI algorithms can continuously capture physiological and behavioral data that are typically obscured in episodic clinical assessments. This section synthesizes contemporary evidence focusing on three primary outcomes: the biomechanical tracking of falls, the longitudinal monitoring of Activities of Daily Living (ADLs) for early pathology detection, and the subsequent impact on healthcare utilization metrics.

Biomechanical tracking and the mitigation of injurious falls represent a central clinical utility of AAL systems [5]. Traditional fall-detection mechanisms have historically relied on wearable technologies, which often suffer from variable patient compliance, limited battery life, and high rates of false positives during standard physical activity [6]. Conversely, contemporary AAL frameworks leverage non-wearable, ambient modalities such as passive infrared sensors and wall-mounted motion detectors processed via machine learning algorithms [7]. These systems evaluate temporal and spatial gait mechanics without requiring physical interaction from the user. When a biomechanical deviation indicative of a fall event occurs, the system initiates an automated alert protocol to designated caregivers or emergency services. Clinical data suggest that while AAL systems may not entirely prevent the mechanical act of falling, they can significantly truncate the critical period an individual remains immobilized post-fall, thereby mitigating severe secondary complications such as rhabdomyolysis, pressure ulcers, and pneumonia [7].

Beyond acute event detection, AAL frameworks provide robust longitudinal tracking of ADLs, which serves as a highly sensitive proxy for detecting insidious cognitive and physical decline [8]. Unobtrusive sensors attached to doors, beds, and major household appliances generate continuous datasets mapping a resident's baseline functional routines. Machine learning models utilize unsupervised anomaly detection to identify statistical deviations from these established baselines [8]. For example, a measured increase in nocturnal bathroom visits, coupled with extended durations per visit, can serve as a reliable early digital biomarker for urinary tract infections (UTIs), a condition that frequently presents atypically with acute delirium rather than standard urological symptoms in the geriatric population. Furthermore, diminished interaction with kitchen appliances, increased irregularities in sleeping patterns, and decreased spatial complexity in indoor navigation routes have shown strong clinical correlations with the early progression of mild cognitive impairment (MCI) and related neurodegenerative disorders [9]. By highlighting these subclinical functional deteriorations, AAL empowers healthcare providers to implement targeted, timely interventions before an acute clinical exacerbation occurs, effectively shifting the paradigm of geriatric care from reactive to proactive management.

The proactive, continuous monitoring capabilities of AAL technologies translate directly into improved systemic healthcare utilization metrics, particularly concerning 30-day hospital readmission rates and overall cost-utility [10]. Older adults discharged to AAL-equipped environments following an acute inpatient stay demonstrate a statistically significant reduction in unplanned hospital readmissions. This reduction is primarily attributed to the algorithmic detection of early physiological destabilization, such as reduced ambulatory activity indicating exacerbated heart failure, or erratic medication access patterns, allowing outpatient clinical teams to intervene well before emergency acute care becomes necessary. Additionally, systematic cost-effectiveness analyses indicate that the initial capital expenditure and maintenance costs associated with deploying AAL infrastructure are frequently offset by the substantial financial savings realized through avoiding prolonged hospitalizations [10]. More importantly, by facilitating a structurally safer and monitored environment that preserves functional autonomy, AAL interventions effectively delay the transition of frail older adults from independent community-based dwellings to high-cost, long-term skilled nursing facilities.

2. Ethical Considerations and Privacy Concerns

The deployment of Ambient Assisted Living (AAL) technologies inherently generates a complex ethical tension between clinical beneficence and patient autonomy [11]. While the primary objective of AAL is to ensure the physical safety and physiological stability of older adults, this goal is frequently achieved through pervasive environmental monitoring [12]. The continuous collection of behavioral telemetry, even when utilizing passive, non-visual sensors, risks undermining a patient's fundamental right to privacy, spatial solitude, and self-determination [11, 13]. Consequently, clinicians and biomedical engineers must continuously balance the mitigation of acute health risks against the preservation of individual autonomy, as older adults may perceive ubiquitous sensor networks as highly intrusive [13]. When safety is prioritized at the absolute expense of privacy, the fundamental dignity of the aging individual can be compromised, necessitating rigorous ethical guidelines during the initial deployment of these systems [11].

This ethical calculus becomes exceptionally complex when AAL systems are deployed for individuals experiencing mild cognitive impairment (MCI) or progressive neurodegenerative diseases, such as Alzheimer's dementia [12]. In these vulnerable clinical populations, obtaining and maintaining informed consent is significantly complicated by the progressive decline of executive function and decision-making capacity [14]. Traditional informed consent is structured as a static, one-time event; however, ethical dementia care requires a framework of dynamic consent, wherein a patient's understanding of, and agreement to, continuous environmental surveillance must be routinely reassessed as their cognitive status inevitably fluctuates [11, 14]. Frequently, the deployment of AAL in the homes of cognitively impaired adults relies heavily on surrogate decision-making by adult children, family members, or legally appointed guardians [14]. While surrogates generally prioritize the patient's physical safety and seek to alleviate their own caregiver burden, this reliance can inadvertently marginalize the patient's immediate or localized objections to being monitored. Such dynamics raise significant concerns regarding medical paternalism and the potential overriding of the patient's residual agency, particularly when the patient exhibits distress in response to the technology [12, 14].

Furthermore, the integration of passive sensors, cameras, and microphones into residential architecture facilitates a profound medicalization of the domestic sphere [15]. Historically, the home has served as a private sanctuary, fundamentally distinct from clinical environments like hospitals or skilled nursing facilities. The continuous, visible presence of motion detectors, bed pressure sensors, and algorithmic telemetry functionally transforms the residence into a secondary clinical setting [13]. This medicalization can exert a substantial psychological impact on community-dwelling older adults, potentially inducing heightened anxiety, hypervigilance, and a phenomenon akin to the "Hawthorne effect," where individuals continuously modify or restrict their natural behavior due to the awareness of being observed [15]. The feeling of being subjected to panoptic surveillance can erode the psychological comfort and intrinsic familiarity of the home environment, paradoxically diminishing the subjective quality of life that AAL interventions are ostensibly designed to preserve [13, 15].

Finally, the systemic implementation of smart home healthcare architectures necessitates a critical evaluation of data sovereignty and informational privacy [14]. Modern AAL systems generate massive, continuous datasets comprising highly sensitive clinical telemetry, longitudinal behavioral routines, and intimate physiological metrics [13]. Much of this data is routed through proprietary algorithms developed and maintained by third-party commercial entities, rather than traditional healthcare institutions [15]. This architectural reliance on private technology infrastructure introduces significant systemic risks regarding unauthorized data mining, the secondary commercialization of health data, and potential cybersecurity vulnerabilities [14, 15]. Establishing robust regulatory frameworks is critical to ensure that absolute data sovereignty remains with the patient or their designated clinical proxies. These protections are essential to prevent commercial stakeholders from leveraging clinical telemetry for non-medical profiling, predictive analytics, or targeted marketing, thereby upholding the strict principles of medical confidentiality in an increasingly digitized and outsourced geriatric care landscape [15].

3. Socioeconomic Disparities and Structural Barriers to Adoption

While Ambient Assisted Living (AAL) technologies offer substantial clinical utility, their unchecked commercial deployment risks exacerbating existing disparities in health equity [16]. The proliferation of these advanced sensor networks has inadvertently widened the "digital divide" within the geriatric population, bifurcating access to preventative, technology-driven care along socioeconomic lines [17]. Unlike ubiquitous consumer electronics, medically validated smart home infrastructures impose formidable financial barriers that disproportionately exclude low-income and historically marginalized older adults. The initial capital expenditure for comprehensive passive sensor arrays, edge-processing hubs, and continuous system maintenance is substantial [18]. Currently, third-party payers and governmental insurance programs largely categorize preventative AAL installations as out-of-pocket expenses, refusing comprehensive reimbursement for ambient surveillance systems despite their documented potential to reduce overall hospital utilization [17]. This lack of financial subsidization severely restricts AAL adoption to affluent demographics, effectively transforming a vital clinical tool into a luxury commodity.

Beyond direct financial constraints, severe infrastructural barriers impede the equitable deployment of AAL technologies, particularly in rural and underserved geographies [16]. Edge-AI systems, while processing localized data, still demand robust, high-speed broadband internet connectivity to transmit acute alerts, push algorithmic updates, and synchronize baseline telemetry with remote clinical dashboards. The persistent lack of reliable broadband infrastructure in rural areas acts as a structural bottleneck, rendering AAL technologies functionally inoperable for older adults residing outside of urban or digitally modernized centers [18].

Compounding these socioeconomic and infrastructural challenges is the pervasive risk of algorithmic bias embedded within the artificial intelligence models driving AAL anomaly detection [19]. The machine learning algorithms underpinning passive environmental sensors are predominantly trained on vast datasets sourced from early adopters, typically affluent, non-minority populations residing in spacious, modern architectural environments [20]. Consequently, these models often fail to generalize effectively across diverse socioeconomic and cultural contexts. For instance, algorithmic baselines for spatial complexity and gait analysis may generate elevated error rates and false-positive alerts when deployed in multi-generational households, cramped urban apartments, or among patients with differing cultural routines [19]. Because the foundational training data lacks representative diversity, minority and low-income populations are inadvertently subjected to decreased diagnostic accuracy and algorithmic unreliability [20]. Addressing this systemic bias requires a concerted regulatory effort to mandate diverse, representative clinical training sets, ensuring that technological advancements in geriatric care do not institutionalize diagnostic inequalities.

Discussion

The integration of Ambient Assisted Living (AAL) technologies into modern geriatric care presents a profound intersection of clinical innovation, ethical complexity, and socioeconomic vulnerability. The synthesized literature demonstrates that edge-AI passive sensors offer substantial clinical efficacy, successfully functioning as unobtrusive, continuous early warning systems for injurious falls and the insidious onset of cognitive and physiological decline [21]. However, this clinical utility is fundamentally constrained by a precarious risk-versus-reward paradigm. The primary clinical benefit must be meticulously weighed against the inherent risks of continuous environmental surveillance [22]. When older adults are subjected to ubiquitous monitoring, the preservation of their physical safety frequently comes at the direct expense of their spatial privacy and psychological autonomy. This dynamic risks transforming the private domestic sphere into a medicalized environment, which can induce anxiety, hypervigilance, and an erosion of the patient's fundamental dignity and agency [23].

Furthermore, the existing literature strongly indicates that this risk-versus-reward calculus is currently a privileged dilemma. The severe socioeconomic barriers associated with establishing AAL infrastructure have inadvertently bifurcated access to advanced geriatric care [24]. Because comprehensive smart home sensor arrays require substantial out-of-pocket capital, ongoing maintenance costs, and reliable high-speed broadband connectivity, their deployment is largely restricted to affluent, digitally literate populations residing in urban or suburban centers [22]. This persistent digital divide threatens to institutionalize a two-tiered healthcare ecosystem where structurally marginalized older adults who often present with the highest clinical need for multi-morbidity management, are systematically excluded from the benefits of proactive, technology-driven care, thereby widening existing systemic health disparities [21].

To effectively mitigate these systemic disparities, it is imperative to establish robust clinical implementation frameworks and targeted public policies. First, healthcare systems, third-party payers, and public insurance programs must formally reclassify medically validated AAL systems from discretionary consumer electronics to essential, reimbursable preventative medical devices [21]. Subsidizing the initial installation and ongoing maintenance of passive sensor networks for low-income older adults is a critical and necessary step toward achieving true digital health equity. Second, biomedical developers and regulatory bodies must rigorously enforce "equity-by-design" principles during the foundational phases of algorithmic development [24]. Because current machine learning models are predominantly trained on telemetry gathered from affluent, non-minority early adopters, they carry a high risk of algorithmic bias. This bias inevitably results in elevated error rates and false-positive alerts when systems are deployed among diverse demographics with differing architectural layouts, multi-generational household structures, or unique cultural routines [23]. Mandating diverse, globally representative clinical datasets for AI training is essential to ensure algorithmic fairness across all socioeconomic strata.

Finally, a critical evaluation of contemporary literature reveals significant methodological limitations that must guide future empirical research. There is a pronounced lack of robust, longitudinal studies investigating the long-term clinical outcomes and psychological impacts of AAL systems specifically within marginalized, low-income, and rural geriatric demographics [22, 23]. The majority of current pilot and feasibility studies feature small, homogenous sample sizes consisting primarily of highly educated populations, fundamentally limiting the generalizability of the reported findings. Future research initiatives must prioritize cross-cultural, longitudinal evaluations of AAL deployments in socially deprived areas. Only by understanding the intersectional, structural barriers to adoption can clinicians and engineers refine these advanced technologies for equitable, universal application in the rapidly aging global population [24].

Conclusions

The global demographic shift toward an aging population necessitates scalable interventions to manage the escalating clinical burden of geriatric multi-morbidity. As synthesized in this review, Ambient Assisted Living (AAL) technologies, specifically edge-AI passive sensor networks, demonstrate substantial clinical efficacy by transitioning care from reactive to proactive paradigms. Continuous, unobtrusive monitoring of biomechanics and Activities of Daily Living facilitates the early detection of falls and insidious cognitive or physiological decline, thereby reducing unplanned hospital readmissions and safely delaying long-term institutionalization.

However, the unchecked deployment of AAL ecosystems introduces profound ethical and structural challenges. The tension between medical beneficence and patient autonomy necessitates rigorous frameworks to address the privacy implications of continuous surveillance, the complexities of dynamic consent, and the psychological impact of medicalizing the domestic sphere. Furthermore, without intentional systemic interventions, AAL technologies risk exacerbating existing health inequities. Prohibitive out-of-pocket costs, algorithmic biases, and the prerequisite of robust broadband infrastructure currently restrict these advanced clinical tools to affluent demographics, significantly widening the digital divide.

Ultimately, the future viability of AAL in geriatric medicine relies on more than technological optimization. Systemic integration demands a multidisciplinary approach: healthcare payers must formally subsidize AAL as essential preventative infrastructure, and biomedical developers must mandate equity-by-design principles in algorithmic training. Only through the deliberate synthesis of clinical innovation with rigorous bioethical standards and universally equitable access models can smart home technologies fulfill their potential to safely and justly support the aging population in place.

Author's contributions:
Conceptualization: Antoni Kantor
Methodology: Kacper Raputa, Wiktor Rybicki
Software: Bartosz Kus, Jakub Gościński
Check: Michał Tutaj, Marta Godyń
Formal analysis: Wiktor Rybicki, Kacper Raputa
Investigation: Kacper Raputa, Aniela Kupiec, Mateusz Pietrasz
Resources: Marta Godyń, Bartosz Kus
Data curation: Igor Kania, Michał Tutaj
Writing-rough preparation: Michał Tutaj, Kacper Raputa, Jakub Gościński
Writing-review and editing: Wiktor Rybicki, Aniela Kupiec, Mateusz Pietrasz
Visualization: Bartosz Kus, Igor Kania
Supervision: Antoni Kantor, Marta Godyń, Mateusz Pietrasz
Project administration: Antoni Kantor, Kacper Raputa

All authors have read and agreed with the published version of the manuscript.
Funding Statement: The article did not receive any funding.
Conflict of Interest Statement: Authors declare no conflict of interest.

REFERENCES

1. Vollmer Dahlke, D., Lee, S., Smith, M. L., Shubert, T., Popovich, S., & Ory, M. G. (2021). Attitudes toward technology and use of fall alert wearables in caregiving: Survey study. *JMIR Aging, 4*(1), e23381. https://doi.org/10.2196/23381
2. Turjamaa, R., Pehkonen, A., & Kangasniemi, M. (2019). How smart homes are used to support older people: An integrative review. *International Journal of Older People Nursing, 14*(4), e12260. https://doi.org/10.1111/opn.12260
3. Choi, Y. K., Thompson, H. J., & Demiris, G. (2020). Use of an Internet-of-Things smart home system for healthy aging in older adults in residential settings: Pilot feasibility study. *JMIR Aging, 3*(2), e21964. https://doi.org/10.2196/21964
4. Cao, L., Feng, S., Chen, K., Wu, X., & Jia, Y. (2025). An ethical model for smart home-based elder care. *Nursing Ethics, 32*(6), 1783–1798. https://doi.org/10.1177/09697330241312383
5. Facchinetti, G., Petrucci, G., Albanesi, B., De Marinis, M. G., & Piredda, M. (2023). Can smart home technologies help older adults manage their chronic condition? A systematic literature review. *International Journal of Environmental Research and Public Health, 20*(2), 1205. https://doi.org/10.3390/ijerph20021205
6. Jovanovic, M., Mitrov, G., Zdravevski, E., Lameski, P., Colantonio, S., Kampel, M., Tellioglu, H., & Florez-Revuelta, F. (2022). Ambient assisted living: Scoping review of artificial intelligence models, domains, technology, and concerns. *Journal of Medical Internet Research, 24*(11), e36553. https://doi.org/10.2196/36553
7. Flor-Unda, O., Arcos-Reina, R., Estrella-Caicedo, C., Toapanta, C., Villao, F., Palacios-Cabrera, H., Nunez-Nagy, S., & Alarcos, B. (2025). A comparative overview of technological advances in fall detection systems for elderly people. *Sensors, 25*(24), 7423. https://doi.org/10.3390/s25247423
8. Jalali, N., Sahu, K. S., Oetomo, A., & Morita, P. P. (2020). Understanding user behavior through the use of unsupervised anomaly detection: Proof of concept using Internet of Things smart home thermostat data for improving public health surveillance. *JMIR mHealth and uHealth, 8*(11), e21209. https://doi.org/10.2196/21209
9. Grammatikopoulou, M., Lazarou, I., Alepopoulos, V., Mpaltadoros, L., Oikonomou, V. P., Stavropoulos, T. G., Nikolopoulos, S., Kompatsiaris, I., & Tsolaki, M. (2024). Assessing the cognitive decline of people in the spectrum of AD by monitoring their activities of daily living in an IoT-enabled smart home environment: A cross-sectional pilot study. *Frontiers in Aging Neuroscience, 16*, 1375131. https://doi.org/10.3389/fnagi.2024.1375131
10. Majumder, S., Aghayi, E., Noferesti, M., Memarzadeh-Tehran, H., Mondal, T., Pang, Z., & Deen, M. J. (2017). Smart homes for elderly healthcare-recent advances and research challenges. *Sensors, 17*(11), 2496. https://doi.org/10.3390/s17112496
11. Hine, C., Nilforooshan, R., & Barnaghi, P. (2022). Ethical considerations in design and implementation of home-based smart care for dementia. *Nursing Ethics, 29*(4), 1035–1046. https://doi.org/10.1177/09697330211062980
12. Chimamiwa, G., Giaretta, A., Alirezaie, M., Pecora, F., & Loutfi, A. (2022). Are smart homes adequate for older adults with dementia? *Sensors, 22*(11), 4254. https://doi.org/10.3390/s22114254
13. Schoenfeld, E. R., Trimboli, T., Schwartz, K., Ayisi-Boahene, G., Bruckenthal, P., Zadok, E., Horwitz, S., & Ye, F. (2025). Engaging older adults to guide the development of passive home health monitoring to support aging in place. *Sensors, 25*(24), 7413. https://doi.org/10.3390/s25247413
14. Wilkowska, W., Offermann, J., Spinsante, S., Poli, A., & Ziefle, M. (2022). Analyzing technology acceptance and perception of privacy in ambient assisted living for using sensor-based technologies. *PLOS ONE, 17*(7), e0269642. https://doi.org/10.1371/journal.pone.0269642
15. Tian, Y. J. A., Duong, V., Buhr, E., Felber, N. A., Schwab, D. R., & Wangmo, T. (2025). Monitored and cared for at home? Privacy concerns when using smart home health technologies to care for older persons. *AJOB Empirical Bioethics, 16*(2), 61–76. https://doi.org/10.1080/23294515.2024.2416121
16. Seifert, A., Cotten, S. R., & Xie, B. (2021). A double burden of exclusion? Digital and social exclusion of older adults in times of COVID-19. *The Journals of Gerontology: Series B, Psychological Sciences and Social Sciences, 76*(3), e99–e103. https://doi.org/10.1093/geronb/gbaa098
17. Rodriguez, J. A., Clark, C. R., & Bates, D. W. (2020). Digital health equity as a necessity in the 21st Century Cures Act era. *JAMA, 323*(23), 2381–2382. https://doi.org/10.1001/jama.2020.7858
18. Sieck, C. J., Sheon, A., Ancker, J. S., Castek, J., Callahan, B., & Siefer, A. (2021). Digital inclusion as a social determinant of health. *NPJ Digital Medicine, 4*(1), 52. https://doi.org/10.1038/s41746-021-00413-8
19. Norori, N., Hu, Q., Aellen, F. M., Faraci, F. D., & Tzovara, A. (2021). Addressing bias in big data and AI for health care: A call for open science. *Patterns (New York, N.Y.), 2*(10), 100347. https://doi.org/10.1016/j.patter.2021.100347
20. Cirillo, D., Catuara-Solarz, S., Morey, C., Guney, E., Subirats, L., Mellino, S., Gigante, A., Valencia, A., Rementeria, M. J., Chadha, A. S., & Mavridis, N. (2020). Sex and gender differences and biases in artificial intelligence for biomedicine and healthcare. *NPJ Digital Medicine, 3*, 81. https://doi.org/10.1038/s41746-020-0288-5
21. Masterson Creber, R., Dodson, J. A., Bidwell, J., Breathett, K., Lyles, C., Harmon Still, C., Ooi, S. Y., Yancy, C., Kitsiou, S., & American Heart Association Cardiovascular Disease in Older Populations Committee of the Council on Clinical Cardiology and the Council on Cardiovascular and Stroke Nursing; Council on Quality of Care and Outcomes Research; and Council on Peripheral Vascular Disease (2023). Telehealth and health equity in older adults with heart failure: A scientific statement from the American Heart Association. *Circulation: Cardiovascular Quality and Outcomes, 16*(11), e000123. https://doi.org/10.1161/HCQ.0000000000000123

22. Chadwick, H., Laverty, L., Finnigan, R., Elias, R., Farrington, K., Caskey, F. J., & van der Veer, S. N. (2024). Engagement with digital health technologies among older people living in socially deprived areas: Qualitative study of influencing factors. *JMIR Formative Research, 8*, e60483. https://doi.org/10.2196/60483
23. Khan, S., Webster, S., Puxty, J., & Robertson, M. (2026). Key challenges and barriers to digital literacy for older adults: Scoping review. *JMIR Aging, 9*, e80647. https://doi.org/10.2196/80647
24. Elechi, U., Orobator, E. T., Udoh, K., Ngozi, E. O., Uzoma, C. A. E., Forson, K. A. A. M., Akanbi, O. O., & Tarawallie, M. A. (2025). Artificial intelligence in healthcare: A narrative review of recent clinical applications, implementation strategies, and challenges. *Journal of Healthcare Leadership, 17*, 863–876. https://doi.org/10.2147/JHL.S553748