Smart Homes as a Support for Independent Living in People with Functional Dependence

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Abstract
The smart home is a residential environment equipped with sensors, connected devices, home automation, voice assistants, alert systems and remote monitoring platforms. These technologies make it possible to perceive events in the domestic space, support daily routines and facilitate communication with caregivers or professionals. From this perspective, the smart home can foster independent living for people with functional dependence, understood as the limitation in performing basic and instrumental activities of daily living and the consequent need for human, environmental and technological support. This article presents a narrative literature review on the use of smart home technologies in people with functional dependence, considering mixed profiles associated with advanced age, reduced mobility and physical or cognitive disability. The work was carried out exclusively with Scopus documents, in English, published between 2021–2026. The results show that the most relevant functionalities are concentrated in safety, fall detection, monitoring of activities of daily living, reminders, environmental control and communication with caregivers. Likewise, the literature indicates potential benefits in perceived autonomy, family peace of mind, continuity of care and remaining at home, although barriers related to privacy, usability, cost and validation in real-world settings persist.

Keywords
smart home, functional dependence, independent living, assistive technology, ambient assisted living

1. Introduction

In recent decades, the place where people age or live with a disability has ceased to be a purely family matter and has become an issue of public health, urban design and social policy. For most people, remaining in one's own home is not just a preference regarding where to live, but the possibility of maintaining familiar routines, social bonds and a sense of control over daily life that specialized residential environments can rarely replicate. However, when advanced age, a disability or a chronic illness begin to erode the conditions that make that life at home possible, the usual response has been transfer to care centers or an increase in the burden on family members and informal caregivers. Kim et al. [1] and Wang et al. [2] argue that the smart home emerges precisely as an alternative capable of changing this equation, by shifting part of the monitoring and support function toward the domestic environment itself.

This shift is only possible if the home itself stops being a passive space and becomes an environment capable of perceiving, responding and adapting, which is precisely what characterizes the smart home, a residential space that integrates sensors, connected devices, automation and digital services to perceive what occurs in the dwelling and act on it automatically or semi-automatically. In the assistive context, Chan et al. [3] and Ghafurian et al. [4] specify that this infrastructure goes beyond conventional home automation, since its purpose is to sustain independent living through risk detection, routine

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monitoring, environmental control, reminders and communication among users, family members and professionals. Available solutions range from motion and opening sensors to conversational assistants, medication dispensers or telecare systems. Within this spectrum, Killian et al. [5] and Yeoh Lui et al. [6] have demonstrated the potential of these technologies for fall prevention and detection, while Pérez et al. [7] and Márquez and Taramasco [8] extend that scope to the recognition of activities of daily living and support for caregivers.

Now then, defining the technology is not enough if the population it targets is not defined with equal precision. Functional dependence can be understood as the need for support with basic activities such as mobility, personal hygiene or feeding, or with instrumental activities such as cooking, managing medication or maintaining home safety. An older person with cognitive decline who forgets to turn off the stove, an adult with multiple sclerosis who needs to adjust the temperature without moving, or someone recovering from a hip fracture who requires overnight supervision represent very different profiles that nonetheless share the same need for an environment that compensates for their limitations without replacing their agency. This diversity of situations has direct consequences for design, since Chan et al. [3] and Márquez and Taramasco [8] emphasize that solutions must be flexible and configurable, adapted to the capabilities and environment of each person, rather than prescribing generic automations. In the population with disabilities, Jamwal et al. [9] add that communication, access to the environment and daily support must be treated as integrated dimensions rather than isolated functions. However, the technical capacity to solve a problem does not guarantee its adoption in real life, since Ghorayeb et al. [10] and Street et al. [11] warn that incorporating the expectations of the users themselves from early stages is a necessary condition to avoid technically sound but poorly accepted solutions, and Ghorayeb et al. [12] show that co-design is the mechanism that allows domestic data to be translated into interfaces that are understandable and appropriable by older people.

Despite this potential, existing research presents gaps that limit its practical application. Studies on fall prevention, activity recognition or remote monitoring have largely been developed independently, without establishing explicit links between the available technological functionalities and the specific functional needs of users. A large part of the evidence comes from laboratory settings or prototypes with small samples, which makes it difficult to assess whether the observed benefits hold up under real domestic conditions and over extended periods. In addition, disciplines such as digital health, Ambient Assisted Living (AAL), accessibility and assistive technology have tended to develop their own conceptual frameworks and evaluation criteria without converging on a common vision, making it difficult to determine which combinations of technology and context produce real improvements in the autonomy, safety or quality of life of people with functional dependence. This lack of integrative synthesis is precisely the gap that motivates the present work, which is guided by the following research questions:

- **RQ1.** Which smart home functionalities are most useful for people with functional dependence?
- **RQ2.** How does the quality of life of these people improve when they incorporate smart home technologies into their domestic environment?

On this basis, the rest of the article is organized as follows. Section 2 defines the central concepts, Section 3 describes the review strategy based on Scopus, Section 4 synthesizes the results, Section 5 discusses findings and gaps, Section 6 sets out the limitations, and Section 7 presents the conclusions.

2. Conceptual framework

2.1. Functional dependence

For a long time, functional dependence was understood mainly as an attribute of the person, something one had or did not have depending on diagnosis or age. That view has gradually given way to a more nuanced understanding that regards it as a dynamic relationship between the person's capabilities, the demands of daily tasks, the conditions of the physical environment and the supports available. This distinction matters because it shifts the focus from deficit toward context: the same limitation can translate into greater or lesser dependence depending on what the environment offers or restricts. From that perspective, Kim et al. [1] show that changes in activity patterns and space usage make it possible to detect gradual functional variations that would otherwise go unnoticed, while Chan et al. [3] specify that this information is only useful when it is understandable and relevant to those who must act on it, whether the users themselves or their caregivers.

Understood in this way, functional dependence encompasses needs that go beyond mobility or self-care. Pérez et al. [7] link it to specific requirements for safety, memory and communication that shape domestic life on a daily basis. Wang et al. [2] add that independence is not equivalent to the absence of support, but rather to receiving proportionate, configurable and timely assistance that preserves personal agency instead of replacing it. This nuance is especially relevant for people with cognitive decline, since Moyle et al. [13] warn that in this group dependence can worsen not only due to disease progression, but also due to caregiver overload or difficulty sustaining stable routines. Based on these considerations, this review adopts functional dependence as a relational category that makes it possible to analyze how limitations in everyday activities can be compensated for through human, environmental and technological supports aimed at preserving autonomy, safety and quality of life at home.

2.2. Smart home

If functional dependence is understood as a relationship between the person and their environment, it is natural to ask what that environment can offer when it is actively designed to compensate for limitations. The answer that has been taking shape in recent years points to the smart home, a residential space equipped with computational and communication devices capable of perceiving events, inferring states and executing automatic or semi-automatic actions. Kim et al. [1], Chan et al. [3] and Márquez and Taramasco [8] use related terms such as AAL, assistive home, advanced telecare or home monitoring to describe variants of this same field, and Vrancic et al. [14] emphasize that its value is enhanced when the technological infrastructure is integrated with family, professional and community care networks.

From a technical standpoint, these solutions combine components that operate in a coordinated manner. Non-invasive environmental sensors make it possible to infer presence, room usage, door opening or nighttime activity without requiring direct intervention from the user. Wearable devices complement this information with physiological signals and body-movement data, while actuators make it possible to intervene in the environment by controlling lights, temperature, appliances or access points. Pérez et al. [7], Márquez and Taramasco [8] and Wang et al. [2] warn, however, that the real usefulness of this architecture depends on its components being interoperable, robust and acceptable to those who use them. Along these lines, Kim et al. [15], Gordon et al. [16] and Kang et al. [17] show that solutions such as smart lighting, voice interfaces or co-designed technology packages can contribute to safety, accessibility and the perception of control when they are adapted to the real domestic routines of each person.

2.3. Assistive technology

What distinguishes assistive technology from any other supporting technology is a question that has gained renewed relevance as homes have filled with connected devices. In its most precise sense, assistive technology encompasses the set of devices, systems and services designed to maintain or improve the functional capacity of people with disability or dependence, but its scope has been profoundly transformed since these solutions stopped being portable, individual tools and became integrated into the domestic environment itself as part of a continuous and contextual support ecosystem [3, 7, 8]. When that integration takes place in a smart home, Chan et al. [3] and Wang et al. [2] note that the value of the resulting solutions depends less on their technical sophistication than on their fit with the functional profile, the family context and the privacy preferences of each user [7, 8]. Kang et al. [17] and Moon et al. [18] reinforce this idea by showing that automation and voice control are only effective when calibrated to the person's actual level of autonomy, while Felber et al. [19] warn that the continuous collection of domestic data raises ethical questions of consent and agency that go beyond the technical realm. Building on this, Chan et al. [3] and Márquez and Taramasco [8] conclude that evaluating these technologies requires balancing safety, autonomy, acceptability and sustainability, without assuming that the most advanced solution is necessarily the most appropriate one [2].

3. Review methodology

3.1. Review design

A narrative literature review was carried out with the aim of identifying trends, functionalities and reported effects of smart homes for people with functional dependence. The search, screening, eligibility assessment and final selection of documents were structured following the PRISMA 2020 protocol guidelines [20], adapted to the particular characteristics of a narrative review.

3.2. Information source and search period

The bibliographic search of the main corpus was conducted exclusively in Scopus, as it was the database used throughout the development of the work and because it offers broad coverage of peer-reviewed literature in computer science, digital health, biomedical engineering and applied social sciences. The search was limited to documents in English published between 2021 and 2026, and retrieved 236 initial records. All citations included in the body of the article correspond to the 2021–2026 period, in accordance with the temporal criterion defined for the corpus.

3.3. Search strategy

The search strings were formulated in English to maintain consistency with Scopus coverage and include the following terms: “smart home”, “ambient assisted living”, “assistive technology”, “independent living”, “older adults”, “functional dependence”, “disability”, “activities of daily living”, “quality of life”, “fall detection” and “remote monitoring”. The selection of these descriptors was based on previous reviews focused on aging in place, smart housing and independent living [1, 3], which made it possible to steer the search toward technologies with an assistive purpose and exclude literature related to general-purpose home automation.

3.4. Selection and screening criteria

After conducting the search with the terms described above, 236 records were retrieved in Scopus, of which 38 were removed before screening for various reasons, leaving 198 records for evaluation. In a first phase, screening by title, abstract and keywords was applied, resulting in the exclusion of 117 records and the preselection of 81. Of these, 3 could not be retrieved in full text, so 78 records were evaluated in depth to determine their eligibility. Following this evaluation, 52 documents were excluded: 41 for lacking an assistive or care purpose, being focused on energy efficiency or comfort-oriented home automation unrelated to functional dependence, and 11 for lacking clinical or functional relevance to the target population. The process concluded with the inclusion of 26 studies. Priority was given to recent reviews, empirical studies, prototypes evaluated with users or caregivers, and applied computing articles related to health and home-based assistance, which made it possible to incorporate work on dementia, disability, user experience, privacy and quality of life [13, 9, 21, 19, 22]. The complete identification, screening, eligibility and inclusion flow is presented in Figure 1.

3.5. Data extraction and analysis

The 26 included studies, published between 2021 and 2026, were analyzed using an extraction template that recorded the user profile, the technology studied, the main functionality and the relevant finding. The synthesis was organized around the two research questions: RQ1 grouped the functionalities

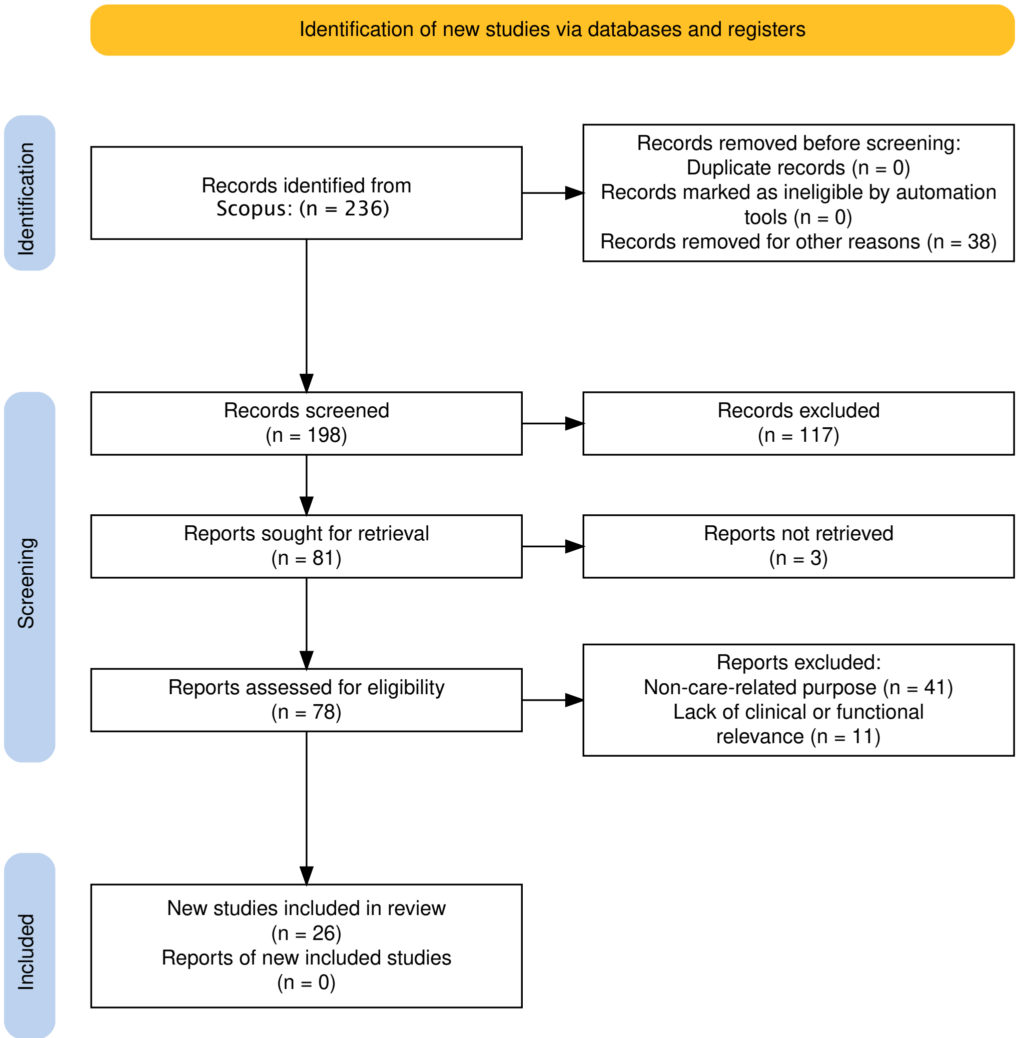

Figure 1: PRISMA 2020 flow diagram of the study selection process.

identified according to the type of support offered, while RQ2 examined the reported effects on autonomy, safety, well-being, caregiver burden and remaining at home.

4. Review results

This section synthesizes the main findings of the reviewed corpus according to the two research questions. First, the smart home functionalities with the greatest assistive value for people with functional dependence are described. Second, the reported effects on quality of life, autonomy, safety, well-being and care support are examined.

4.1. Most relevant functionalities

With regard to RQ1, recent literature indicates that monitoring activities of daily living is one of the most recurrent functionalities in assistive smart homes. In these systems, motion, contact, pressure, electricity-consumption and water-usage sensors make it possible to infer sleep patterns, feeding, indoor mobility and room usage. For people with functional dependence, this capability is useful because it offers continuous supervision without requiring the permanent physical presence of a caregiver [1, 3, 7, 2]. Recent work on smart home platforms, activity analysis and home-support solutions reinforces the need for monitoring to produce information that is actionable for the user and understandable for the caregiver [23, 24, 25]. Building on this observational capability, safety and emergency detection constitute a second line of application. Fall detection is addressed through wearable sensors, cameras, environmental sensors, social robots or hybrid combinations. Alerts for smoke, gas, open doors, abnormal kitchen use and absence of movement are also included. These functions are especially relevant when the person lives alone, is frail or requires a rapid response from family members and support services [1, 3, 5, 2].

As a complement to safety, environmental control and automation appear as relevant supports for reducing physical and cognitive demands. This category includes automatic lighting, thermostats, blinds, locks, appliances and voice assistants, functions that can increase the sense of control over the environment and reduce dependence on others for repetitive actions when designed with simple, configurable interfaces [7, 8, 17, 2]. However, the evidence on lighting, co-designed interfaces and personalized solutions warns that accessibility must be evaluated in terms of concrete household tasks and not merely as a technical attribute of the device [15, 12, 26]. Likewise, support for memory, therapeutic adherence, communication and telecare are key functionalities for users with mild cognitive decline, complex routines or supervision needs. These technologies can also support the management of chronic conditions, provided that the information generated is interpretable and useful for decision-making [21]. In addition, medication reminders, calendars, contextual alarms and conversational assistants can sustain everyday habits and reduce critical lapses, although their acceptance depends on their being timely, non-intrusive and adjustable by users or caregivers [3, 8, 2]. To better understand this dynamic, Table 1 summarizes the functionalities identified, the representative technologies, the target population and the associated references.

Table 1
Functionalities of assistive smart homes identified in the literature (RQ1).

Functionality	**Representative technologies**	**Target population**	**References**
ADL monitoring	Motion, contact, pressure, electricity-consumption and water-usage sensors	General functional dependence	[1, 3, 23, 24, 25]
Fall and emergency detection	Wearable sensors, cameras, environmental sensors, social robots	Frailty and people living alone	[1, 3, 5, 2]
Environmental control and automation	Automatic lighting, thermostats, blinds, locks, voice assistants	Reduced mobility	[7, 8, 17, 15, 12, 26, 2]
Cognitive support and therapeutic adherence	Medication reminders, calendars, contextual alarms, conversational assistants	Mild cognitive decline and people with chronic conditions	[21, 3, 8, 2]

4.2. Impact on quality of life

Regarding RQ2, the improvement in quality of life can be interpreted as a multidimensional effect, not limited to technical safety. The smart home can strengthen functional autonomy because it allows control of elements of the environment, remembering tasks, receiving discreet support and carrying out everyday actions without constantly requesting help. This effect is relevant insofar as independence is not reduced to living without support, but rather to retaining the capacity to make decisions about routines, schedules and meaningful activities [7, 2]. Building on this foundation of autonomy, event detection and automatic alerts extend the reach of the smart home toward perceived safety. Co-designed technology packages are associated with a greater perception of safety among older adults living in the community [16], and safer-home solutions are linked to improvements in quality of life and health outcomes for people who remain in their homes [27]. This improvement not only protects against accidents, but also reduces anxiety among users and family members, especially when the person lives alone or is at risk of disorientation. The availability of information on routines and relevant events can also reduce caregiver uncertainty and facilitate more timely intervention [1, 3, 2].

That said, the realization of these benefits is not automatic and depends on the balance between safety, privacy and acceptance. A technology that monitors too closely can generate rejection, even if it technically reduces risks. The most commonly cited barriers relate to cost, maintenance, connectivity, digital literacy, interoperability and trust in the accuracy of alerts. Consequently, improving quality of life depends on a person-centered implementation, with informed consent, personalization, technical support, caregiver participation and the possibility of adjusting the level of supervision [3, 28, 29, 8, 2]. Table 2 presents a selection of representative studies from the analyzed corpus.

Table 2
Summary of the impact on quality of life

Author	Year	User profile	Technology studied	Main finding
Kim et al. [1]	2022	Older people at home	Home monitoring	Home monitoring supports aging in place when designed with attention to usability and user acceptance.
Killian et al. [5]	2021	Older people	Cameras and social robot	Fall detection and prevention improve when visual sensors and interactive assistance are combined.
Chan et al. [3]	2022	Older adults	Home health monitoring	Implementation must consider user needs, caregiver burden, privacy and clinical utility of the data.
Perez et al. [7]	2023	People with care dependence	Smart home technologies	Smart solutions favor independence and reduce dependence when adjusted to the user's functional profile.
Marquez and Taramasco [8]	2023	AAL users	AAL systems	The main barriers relate to acceptance, interoperability, privacy, cost and sustainability of use.
Wang et al. [2]	2025	Older adults	Smart home and care	Smart homes are linked to independence, safety and care support, although they require validation in real-world contexts.
Ghorayeb et al. [12]	2023	Older adults	Co-designed interface	Co-design adapts smart home interfaces to the preferences and needs of older users.
Kang et al. [17]	2024	Reduced mobility	Voice assistants	Voice assistants support independence when they respond to the user's specific motor limitations.
Mun et al. [26]	2025	Physical disability	Personalized solutions	Personalization of smart home technologies increases their value as assistive technology.

5. Discussion

5.1. RQ1 findings

Regarding RQ1, the main finding is that the most useful functionalities are not necessarily the most technically advanced, but rather those that connect with critical tasks of daily life. Based on the 2021–2026 corpus, these functionalities can be grouped into five categories comprising activity monitoring, emergency detection, environmental control, reminders and communication with caregivers [1, 3, 7, 4, 2]. Each of these categories provides a distinct type of support. Activity monitoring makes it possible to recognize functional patterns and possible changes in routine, making it a tool for early detection rather than mere surveillance. Emergency detection provides a layer of safety against falls, prolonged inactivity or risky domestic events, although its real value depends on the reliability of the alerts and the responsiveness of the user's social environment. Environmental control reduces physical demands through automation or voice interaction, but its usefulness is compromised when interfaces are not designed for profiles with cognitive or sensory limitations. Reminders support memory, medication and routines, while communication with caregivers connects the home with family, professional or community networks; both functions, however, require a minimum level of digital literacy that is not always guaranteed in the target population [7, 8, 17, 26, 2].

However, what the literature does not resolve with sufficient clarity is the hierarchy among these categories according to the degree of functional dependence. Most studies present all functionalities as equally valid for any user, without distinguishing which combinations are most effective for profiles of mild, moderate or severe dependence. This gap limits the transferability of the findings to clinical contexts or service-planning settings, where technological prescription requires graduation criteria [3, 7, 2].

5.2. RQ2 findings

From the perspective of RQ2, the strongest finding is that quality of life improves when the smart home reinforces the capacity to decide and act within one's own environment. Qiao et al. [22] document that adoption of smart home assistive technology is associated with improvements in health-related quality of life, while Lu et al. [27] provide evidence that living in a safer domestic environment has a positive effect on the well-being and health outcomes of older people who remain in their homes. Both studies agree that technology adds value when it increases perceived autonomy, safety, family peace of mind and continuity of care, but warn that it can lose acceptance if it is perceived as excessive surveillance, if it requires too much configuration, or if it does not adapt to the user's preferences [3, 16, 28, 8, 2].

That said, this positive impact is not uniform and depends on the fit between technology, functional profile and family context. Aguilera-Hermida et al. [30] observe, among residents of retirement communities, that willingness to adopt smart technology varies considerably depending on prior level of autonomy and the degree of institutional support available. Along complementary lines, Landuran et al. [24] evaluate smart home platforms with people with Down syndrome and conclude that understanding the data generated by the system is as decisive for its usefulness as the technology itself. These findings illustrate that the same solution can be a support, a burden or a source of rejection depending on the context. Thus, a motion sensor may be valuable for a person living alone, but intrusive for another with continuous in-person support. Similarly, a voice assistant can improve independence for reduced mobility, but generate frustration if it does not adequately recognize speech, language or user preferences [17, 26].

This pattern of contextual variability shifts the relevant question. It is not whether the smart home improves quality of life, but under what conditions of design, implementation and support it does so. Pirzada et al. [28] point out that ethical frameworks are a structural condition rather than an optional add-on, given that the absence of guarantees regarding privacy and informed consent can compromise user trust even before the technology demonstrates its usefulness. Along the same lines, Li et al. [29] argue that managing personal data in smart domestic environments requires control mechanisms accessible to the user themselves, not only to the system's operators. Taken together, these arguments hold that, in the absence of co-design, personalization, ongoing technical support and effective privacy protection, technology can reproduce or amplify pre-existing inequalities in access to care, rather than compensating for them [3, 7, 8].

5.3. Gaps in the literature

Despite these contributions, the scientific literature reveals several gaps. First, more studies conducted in real homes are needed to assess sustainability and maintenance, although Zhang et al. [23], Proffitt et al. [31] and Schoenfeld et al. [32] show that recent protocols, trials and participatory processes already exist that are moving in that direction. Second, there is less evidence on mixed profiles of functional dependence that combine reduced mobility, cognitive impairment and physical disability. Third, comparative studies on cost-benefit and scalability in health and social care systems are lacking. Fourth, research must more frequently measure person-centered outcomes, such as dignity, control, social participation and caregiver satisfaction [1, 3, 8, 2].

5.4. Implications for the design of assistive solutions

The results show that the design of smart homes for functional dependence must begin with a needs assessment, not with device selection. In profiles with reduced mobility, priorities tend to relate to environmental control, access points, lighting, communication and reducing unnecessary movement. In profiles with cognitive impairment or intellectual disability, reminders, routine supervision, prevention of domestic risks and communication with caregivers become more important [24, 7, 2]. A second implication is the need to design multimodal interfaces. Voice interaction can be useful for users with motor limitations, but it should not be the only available channel, because it can fail in the presence of noise, speech difficulties or low familiarity with conversational assistants. Similarly, mobile applications can facilitate configuration for caregivers, but are not necessarily suitable for all end users. For this reason, the most robust solutions combine contextual automation, simple physical controls, configurable alerts and manual override mechanisms [3, 8, 2].

The third implication relates to data governance. Continuous home monitoring can generate sensitive information about schedules, visits, sleep, eating or periods of inactivity. Systems should therefore apply data minimization, transparency, revisable consent and clear options to pause or limit supervision. This ethical dimension is central to a technology that increases safety but reduces control and may end up being rejected or used intermittently [3, 28, 29, 8]. In addition, implementation must take into account maintenance, technical support and scalability. In this way, initial adoption does not guarantee sustained use if devices require frequent configuration, if batteries fail, if alerts are false, or if different components are not properly integrated. For the context of applied computing, this opens up research opportunities in open architectures, interoperable data models, explainable machine learning and participatory evaluation with users and caregivers [8, 2].

6. Limitations

The main limitation of this review stems from its narrative design. Although the search, selection and reporting process was organized with support from PRISMA 2020, no formal assessment of methodological quality or risk of bias was carried out. On this basis, the results should be interpreted as a narrative synthesis aimed at identifying trends and conceptual relationships, not as an exhaustive estimate of the effect of smart home technologies. Along these lines, an additional limitation stems from having worked exclusively with Scopus. While this decision improves the traceability of references and ensures a bibliographic base with consistent indexing criteria, it may leave out relevant studies indexed in WoS, PubMed, IEEE Xplore, ACM Digital Library, Google Scholar or other regional sources. Related to this, publication bias may exist, given that studies with positive results tend to be more visible in indexed academic databases.

7. Conclusion

Based on the review carried out, the smart home constitutes a relevant line of support for the independent living of people with functional dependence. The literature analyzed between 2021–2026 shows that the functionalities with the greatest assistive value are monitoring of activities of daily living, fall and emergency detection, environmental control, reminders and communication with caregivers. These functions respond to needs that are frequent in profiles of reduced mobility, advanced age, physical disability and cognitive impairment. In addition, in terms of quality of life, smart home technologies can increase autonomy, perceived safety and family peace of mind, as well as favoring remaining at home. Nevertheless, its implementation must avoid a technocentric view. Usefulness depends on privacy, usability, personalization, cost, interoperability and human support. Therefore, the smart home should be understood as a complement to care, not as a substitute for social relationships or professional services. As a projection of this work, future research is recommended to conduct studies in real housing contexts, include diverse profiles of functional dependence, evaluate person-centered outcomes and compare technological architectures in terms of cost, acceptability and sustainability. These lines of work will make it possible to move forward from promising prototypes toward reliable and socially acceptable assistive solutions.

Declaration on Generative AI

During the preparation of this work, the authors used generative artificial intelligence tools to support the organization of ideas, review of writing and improvement of text clarity. The authors reviewed, edited and verified the resulting content, and take full responsibility for the final content of the publication.

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