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Perceptions of Non-Invasive Wearable Technologies for Elderly Care: A Mixed-Methods Study on User Acceptance and Ethical Implications

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Abstract: The objective of this study is to analyze the acceptance and ethical conditions required for the implementation of non-invasive monitoring systems for older adults. Using a mixed-methods design, it integrates focus groups with older adults and a questionnaire with future social and healthcare professionals. The results show a high level of acceptance of wearable technologies that do not use cameras or microphones, highlighting their discreet nature, protection of privacy, and contribution to autonomy and safety. Participants valued person-centered design, transparency in data use, and technologies that complement—rather than replace—human support. The main perceived barriers were cost, lack of training, and the digital divide. These findings indicate that wearable devices can support aging in place when developed through participatory and ethical approaches that respect dignity and promote trust. The study concludes that successful implementation requires user involvement, clear communication, and sustainable strategies for integration into social and healthcare services.

Keywords: Wearable technologies, Wearable sensors, Non-invasive monitoring, Remote health monitoring, User acceptance, Older adults, Ethical design
Categories: C.3, H.4.2, H.5.2, K.4.0, K.4.2
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1 Introduction

The development of portable devices with artificial intelligence, such as smart bracelets and body sensors, has gained significant importance in health and personal care, especially among older populations. These devices allow real-time monitoring of parameters like vital signs, sleep quality, and physical activity levels. They thus provide valuable information to promote preventive, personalized, and quality care [Zorita et al. 2024]. Continuous health monitoring systems are becoming an increasingly viable alternative for tracking the health status of older adults [McNeill et al. 2017].

The World Health Organization (WHO) defines healthy aging as "the process of developing and maintaining the functional ability that enables well-being in older age" [WHO 2017]. Therefore, it is essential to approach health from a holistic perspective. This perspective must consider not only physical factors but also the emotional, social, and environmental aspects that influence the individual as a whole [Angulo-Ramírez et al. 2024].

According to data provided from the Office of Science and Technology of the Congress of Deputies (Office C) [Office C 2023], Spain ranks fourth in Europe in population aged 65 and over. This proportion stands at 20.1%. Furthermore, this figure is expected to continue to grow over the next two decades due to the progressive aging of the baby boom generation. Although longevity represents progress and opportunity, it also poses significant challenges. Consequently, the goal from a social perspective is not only to prolong life, but also to ensure a higher quality of life, health, and well-being [Office C 2023].

In the European context, the European Commission published the Green Paper on aging in 2021. Its aim was to initiate a political debate on strategies needed to address the challenges of demographic aging [European Commission 2021]. Among these challenges, one of the most urgent is the impact of aging on health and care systems, due to increased life expectancy and the growing proportion of older adults in the population [Martín et al. 2024]. Thus, in the near future, the demographic scenario will pose significant challenges for the social and healthcare sector. In line with this, WHO [WHO 2020] has established the Decade of Healthy Aging 2020–2030 as a global strategy that seeks to improve the lives of older adults, in line with the Sustainable Development Goals and the Madrid International Plan of Action on Aging. This, in turn, is likely to lead to an increasingly aging population structure. In the medium and long term, this may result not only in increased longevity but also in a higher prevalence of disability or dependency.

According to data from Eurostat [Eurostat 2020], healthcare is one of the main concerns of the population, as older adults tend to suffer from chronic diseases, which often manifest themselves simultaneously, increasing the demand for long-term care.

In response to this growing demand for healthcare, the aging population is embracing the use of assisted technologies, such as telecare and telemedicine, which enable remote monitoring and medical care [Greenhalgh et al. 2015]. However, given the increase in older adults with chronic diseases and complex needs, these technologies should not be developed in isolation, but rather integrated into person-centered intervention strategies. Telemedicine systems encompass technologies designed to support older adults or those in situations of dependency, with the aim of reducing risks, improving their daily autonomy, and providing greater peace of mind for both them and

their caregivers, especially in contexts where they live alone, whether at home or in specialized centers [Pérolle and Etxeberria 2006]. Older adults often show a marked preference for remaining in their own homes as they age, which is known as aging in place. In fact, older adults' interest in remaining in their homes is determined by various factors, such as their health status, the perception of not becoming a burden to others, and loneliness [Wiles et al. 2012].

In this context, emerging technologies—such as home automation, robotics, and smart devices—can play a key role in promoting personal autonomy and improving quality of life in the home environment [Pinazo-Hernandis 2024]. However, adapting the technological environment would not be enough if a person-centered approach were not simultaneously considered.

From a social work perspective, the incorporation of technologies in the social and healthcare field cannot be separated from an ethical and person-centered approach. As Perron et al. [Perron et al. 2010] warn, the use of information technologies in social work should be aimed at strengthening the processes of support, autonomy, and empowerment of the groups served, rather than replacing human interaction. In this sense, the development of technological solutions for older adults must be aligned with the principles of the discipline, which include human dignity, social justice, and self-determination [General Council of Social Work 2015].

For this reason, Person-Centered Care (PCC) proposes that any planning of support and care should place the person at the center of the process, respecting their wishes and preferences, and ensuring their active participation in both the development and implementation of their care plan [Rodríguez Rodríguez 2013]. It is therefore necessary to develop new strategies that respect each person's individuality [Limón and Chalfoun 2017].

One of the lines of research that has begun to be explored within this approach is the incorporation of portable or wearable technologies as support tools in the care of older adults. These devices allow constant monitoring of the person's condition, while maintaining their personal independence [Ramírez Monterroso 2023]. Products such as the Xiaomi Mi Band activity bracelet have been validated for counting steps and other variables of interest in older adults, with acceptable results in terms of accuracy and usability [Villaverde Benito 2024; Cajas-Jácome et al. 2025].

However, most of these devices are designed for young people or those who are familiar with technology, creating barriers to adoption among older adults, who often face sensory, motor, or cognitive limitations. Although their benefits have been explored in specific contexts, there remains a significant gap between the commercial design of wearables and the real needs of older adults in care settings [Moore et al. 2021].

Another important aspect to consider is that, despite the considerations described above, there is still a digital divide between those who develop technologies and those who will use them. Devices are often designed without the active participation or input of older adults resulting in solutions that are not very intuitive and have low adherence rates. It is therefore essential to develop technologies that place the person at the center of care [Cepeda 2014]. Recent studies have shown that customizing design according to the age of the user significantly improves the acceptance and usability of technologies [Jiang et al. 2024]. This need for alignment between technology and end users is reflected in the most recent initiatives at the European level. Thus, in line with current trends in innovation in the social and healthcare field, the report published by

Muñoz-García et al. [Muñoz-García et al. 2024] highlights three projects aimed at this goal: TIQUE, which proposes a proactive care model for people with advanced heart failure; ROSIA, focused on personalized telerehabilitation in rural areas; and AI3cord, which uses sensors and artificial intelligence to anticipate and prevent frailty through a comprehensive approach to health status.

From an ethical standpoint, the proposed approach aligns with the principles of care ethics and bioethical principlism—autonomy, non-maleficence, beneficence, and justice—placing special emphasis on user autonomy and dignity, in line with the ethical codes of social work and healthcare. This study integrates knowledge from computer engineering, social work, and gerontology to propose a respectful, person-centered model of digital care. Therefore, its objective is to analyze the acceptance, perceptions, and ethical conditions necessary for the implementation of non-invasive monitoring systems in older adults, integrating the perspectives of users and future professionals in the social and healthcare fields. This work is part of the Microchip4Age pilot project "Promoting the health of older adults through microelectronics and smart monitoring," developed by a research group at a Spanish university, and is part of the 2023 call for grants for proof-of-concept projects under the 2021-2023 State Plan for Scientific, Technical, and Innovation Research, within the framework of the Recovery, Transformation, and Resilience Plan.

This work introduces several relevant innovations, including the development of a portable, non-invasive monitoring system designed specifically for older adults. In this study, the term "non-invasive" refers to the absence of image or sound capture systems (cameras and microphones), avoiding any perception of direct surveillance. It does not involve medical procedures, but rather a design that respects the privacy and autonomy of the individual. The study introduces the concept of perceived invasiveness as a key theoretical dimension for evaluating technological acceptance from an ethical and emotional perspective. It also proposes the concept of functional privacy, understood as a design principle that protects without interfering, supports without replacing, and integrates technology into everyday life in a non-stigmatizing way.

The methodology used combines qualitative and quantitative techniques, incorporating both the voices of older adults and the perspectives of future professionals in the social and healthcare field.

The document is organized into five main sections. Section 2 details the materials and methods used, including a technical description of the system developed within the framework of the Microchip4Age project [Section 2.1], as well as the mixed methodological approach applied [Section 2.2 and Section 2.3]. Section 3 presents the results obtained. Section 4 discusses the findings in light of previous studies, highlighting their implications in the field of social and healthcare. Within this section, subsection 4.1 specifically addresses the limitations of the study. Finally, Section 5 presents the main conclusions drawn from this study.

2 Materials and Methods

2.1 System description

As part of the *Microchip4Age* project, an intelligent system has been developed for the non-invasive monitoring of older adults with chronic conditions. Its primary objective

is to support a preventive and personalized home-care model that preserves individual autonomy by integrating discreet technologies into everyday environments. Unlike other surveillance-based systems, it does not rely on cameras or image recordings, thereby prioritizing privacy and user acceptance.

Figure 1 shows the Microchip4Age system. It consists of an integrated network of portable devices (wristbands), fixed beacons, environmental sensors, and a central data analysis platform (Raspberry Pi 4). This architecture enables contextual and non-intrusive monitoring: the wristbands collect movement and relative location data, the fixed beacons triangulate the position in the home, and the environmental sensors detect everyday activities (such as doors being opened). All data is securely sent to the central platform, where it is processed to identify behavior patterns and generate proactive alerts.

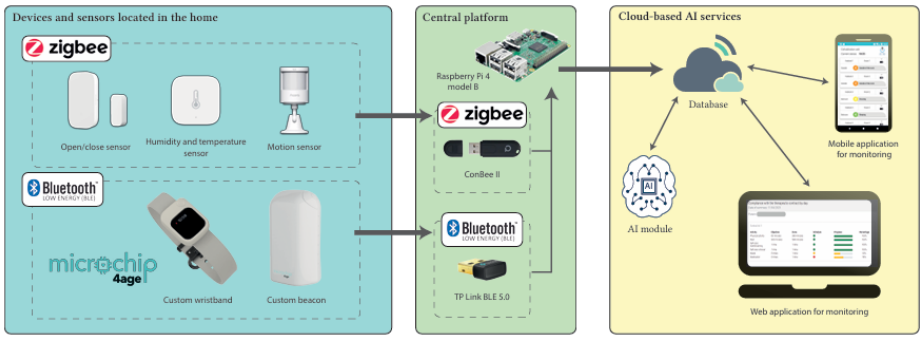


Figure 1: Microchip4Age system

The device developed and presented in this study is a wearable wristband, also referred to as an anchor device. It is small, ergonomic, and lightweight, designed for prolonged use without interfering with daily activities. It is based on a 64 MHz ARM Cortex-M4 processor (nRF52833, Nordic Semiconductor) and supports multiple communication protocols (BLE 5.4, Zigbee, Bluetooth mesh).

It integrates a six-axis inertial measurement unit (LSM6DSM, STMicroelectronics), allowing for the recording of movement, steps, and tilt. The device features a 1-inch OLED display and a capacitive button for a basic interface optimized for older adults. Power management is handled via a 130 mAh LiPo battery, a low-power charger (MP2662), and monitoring through a configurable fuel gauge (LC709204F).

The design incorporates hypoallergenic materials that are resistant to water and dust, and it is adjustable to different wrist sizes, ensuring comfort and durability. Functionally, the wristband performs BLE scanning to detect nearby beacons and exposes the data through a GATT server, to which external devices can subscribe.

Fixed beacons are placed in various areas of the home (rooms, hallways, furniture, etc.) and enable estimation of the user's location via triangulation. These devices use the same architecture as the wristband (nRF52833), operate in either beacon or scanner mode, and are equipped with LED indicators, control buttons, and higher-capacity batteries (1000 mAh). Designed to be unobtrusive, the beacons are discreetly integrated

into the physical environment and do not require continuous interaction or frequent maintenance by the user or caregivers. To enrich the detection of behaviors at home, heterogeneous sensors from the Aqara ecosystem, all CE marked, were incorporated. A detailed technical description of the wearable wristband and the fixed beacons is provided in [Díaz-Jiménez et al. 2025].

These include motion sensors (P1) (https://eu.aqara.com/es-eu/products/aqara-motion-sensor-p1), door and window sensors (https://eu.aqara.com/es-eu/products/aqara-door-and-window-sensor), temperature and humidity sensor (https://eu.aqara.com/es-eu/products/aqara-temperature-and-humidity-sensor), and a connectivity hub (Aqara M3) (https://eu.aqara.com/es-eu/products/aqara-smart-hub-m3). These sensors allow detection of specific actions (such as opening the refrigerator, accessing the bathroom, or leaving a room), expanding the system's ability to identify health-relevant routines.

Data collection and processing are performed through a central platform consisting of a Raspberry Pi 4 Model B with BLE connectivity. This node acts as a hub for concentrating and analyzing data received from the wristband and beacons, enabling location tracking and mobility pattern analysis, real-time monitoring, generation of contextual alerts in case of deviations from usual routines, and communication with the central system server for AI-based processing. Daily activity recognition in the home environment is performed by the AI module, and the resulting information is made available through a mobile application [Montoro Lendínez et al. 2023] and a web-based platform [Díaz-Jiménez et al. 2024], which constitute the main user interaction interfaces.

The system software has been developed on the Zephyr RTOS, allowing for a modular, scalable architecture optimized for low power consumption. During prototyping, official development kits were used to validate hardware and firmware, facilitating interoperability between components and optimization of low-power algorithms.

2.2 Methodological approach

The methodology employed combines qualitative and quantitative techniques, incorporating both the voices of older adults and the perspectives of future professionals in the social and healthcare field.

This integration allows for a deeper and more multidimensional understanding of the factors that influence the acceptance and viability of these technologies. Tashakkori and Teddlie [2010] emphasize that the use of mixed methodologies not only allows research questions that cannot be resolved from a single methodological perspective to be addressed, but also generates a broader perspective that can reveal aspects that are not evident with a single method.

The choice of approach depends on the type of question asked and the level of understanding to be achieved [Pole, 2009]. According to Creswell [2014], this approach allows the strengths of both methods to be integrated, providing more robust and valid results.

2.2.1 Qualitative method

Discussion groups create an environment conducive to dialogue and collective reflection. In this study, they were used as a strategy to strengthen participants' confidence in their own ability to contribute creative and valuable ideas about technology. Interaction between older adults encourages the exchange of experiences and attitudes, acting as a catalyst for debate [Ghorayeb, 2007; Wilkinson, 2004]. By facilitating the collection of direct and contextualized information, it offers a flexible and dynamic approach that allows for in-depth exploration of perceptions and experiences [Huertas & Vigier, 2010].

The qualitative component was implemented through focus groups held at a health center in southern Andalusia (Spain). Older adults participated, intentionally selected to ensure diversity in terms of age, gender, and personal circumstances, with the aim of gathering a plurality of voices and experiences. Participants were shown and allowed to handle the physical prototypes developed in the project: the wearable bracelet (anchor device) and a fixed beacon, both described in Section 2.1. Their movement monitoring, relative location, and presence detection functionalities were explained, with particular emphasis on the fact that neither device incorporates cameras or microphones. This tangible demonstration clearly illustrated the concept of "non-invasive" monitoring central to the study.

At the beginning, the researcher welcomed the participants, explained the purpose and context, and made introductions. Participants were able to ask questions and clarify any concerns before signing the informed consent form to participate in the session. A copy of the consent form was given to all participants, and a second copy was stored securely at the University of (omitted to avoid any identification of the authors). Participants were also informed that an audio recording would be used for data collection and gave their consent for this.

This approach is based on the recognition that the subjectivity, ideologies, identities, and cultural elements of both the researcher and the participants are present throughout the entire study process, from the formulation of the problem to the interpretation and dissemination of the results [González, 2002]. For social work, the qualitative method allows those who do not have a voice to be heard, recognizing people's perspectives, discourses, and stories [Labra et al., 2020]. Throughout the process, compliance with the ethical principles of social research was ensured, especially with regard to confidentiality, anonymity, and respect for the autonomy of the participants.

The information gathering tool was developed by the research group, which created a script of questions covering topics such as: the meaning of technology that cares without invading privacy, fundamental values in design, perceived advantages and disadvantages compared to traditional systems, everyday use cases, user feelings, barriers, necessary guarantees for trust, and implementation recommendations.

Subsequently, the focus group recordings were transcribed verbatim and analyzed using thematic analysis following the approach of [Braun & Clarke, 2006]. After a familiarization phase, initial codes were generated and grouped into central themes (e.g., privacy, trust, and technological discretion; rejection of surveillance; protection, autonomy, and sense of security; design, aesthetics, and ease of use; transparency and personal data management; human support and emotional dimension; and perceived

barriers and economic sustainability) through an iterative review process by the research team.

2.2.2 Quantitative method

The quantitative component used the questionnaire entitled "Perception of future professionals in social and health centers and services on activity recognition systems" (see supplementary material), which was completed by 18 students (n = 18) from the Master's Degree in Management, Administration, and Entrepreneurship of Social and Health Centers and Services at a Spanish University. Although this is a convenience sample, its size is considered adequate for an initial exploratory phase and to capture the perspective of future professionals in training, which is the main objective of this part of the study. The questionnaire was distributed and completed via the Google Forms web platform. The instrument collected structured information on the participants profiles, experiences, and attitudes toward the use of technology in caring for older adults.

3 Results

3.1 Qualitative results

The focus groups revealed a wide range of perceptions, emotions, and assessments among the older adults participating in the *Microchip4Age* project regarding technological monitoring devices.

3.1.1 Privacy, Trust and Technological Discretion

One of the most notable aspects of the responses was concern about invasion of privacy, especially in technologies with cameras or microphones. When introducing the *Microchip4Age* system, the moderator asked, *"What do you think when you hear that there is a technology that takes care of you without cameras or microphones, without you having to do anything?"* Participants reacted overwhelmingly positively, comparing this solution to previous experiences they considered more invasive.

Discretion and the absence of visible surveillance provided a greater sense of peace of mind, facilitating acceptance of the technology. The fact that the device "goes unnoticed" and does not cause discomfort in front of third parties (family members, visitors) is particularly appreciated, which directly influences its integration into the home. Technology must be designed to ensure respect for privacy and dignity [Pinazo-Hernandis, 2024].

> *"I think it's great, [...] above all, it gives me more confidence that it will provide better responses."*
>
> *"Without invading our privacy and in a way taking care of us, it has to be good."*
>
> *"A camera... whether you like it or not, it affects your daily life."*
>
> *"It goes unnoticed. It looks like a home air freshener."*

3.1.2 Meaning of 'Non-invasive' and Rejection of Surveillance

When the moderator asked, *"What do you understand about technology that cares without invading?"*, it became clear that the concept of "non-invasive" is linked to the absence of direct surveillance, but also to a respectful relationship between the user and the technology. Participants reject any form of supervision that resembles control, such as cameras in the home. The social pressure associated with visible technologies was also mentioned, which can cause mistrust among those who visit the home. Knowledge about how the system works and a clear explanation are essential to dispel doubts and increase acceptance.

"This is extraordinary for the patient."
"They are watching you as if you were on a television game show."
"People asked me if they were recording me, if they were watching me."

3.1.3 Protection, Autonomy and Sense of Security

The moderator explored the practical use of technology with the question: *"In what situations do you think this system could be useful?"* The answer was clear: vulnerability and loneliness. Participants highlighted how this type of technology can prevent serious events (fainting, falls) or, at least, trigger an early response.

This type of care is not perceived as a limitation on autonomy, but rather as an extension of self-care, allowing older adults to live alone with greater peace of mind. The possibility of combining independence with emotional protection was key to its acceptance.

"If you faint, this technology detects it and you are no longer alone."
"My sister fainted and perhaps with this technology it would have detected that she was alone on the floor. I would feel protected and I would love to have it."

3.1.4 Design, aesthetics and ease of use

When asked, *"Would you feel uncomfortable wearing this bracelet?",* participants rated its design very positively, describing it as *"attractive," "modern,"* and *"discreet."* Compared to previous technologies, its neutral aesthetics and ability to blend into everyday life without causing stigmatization were highlighted.

The comfort and functional stability of the device were also highlighted, in contrast to older devices that needed to be glued on or came off easily.

"We'll probably forget this new one is even there."
"The way you present it, you don't have to hang it or stick it anywhere, just put it there and leave it."

3.1.5 Transparency and personal data management

A key question was: *"What would we need to know in order to trust this system?".* Trust is linked to transparency in information management. Participants insist on knowing who has access to the data and how it is used. They also highlight the importance of clear and accessible communication about how the system works before it is implemented.

"It's important to know who manages the information we send about our lives."
"Provide clarity. If you agree and accept, you know who will be looking after you."

3.1.6 Human support and emotional dimension

Despite the positive assessment of the system, several participants insisted on the need to complement it with human presence. When asked, *"What advice would you give us to improve the system?"*, they highlighted the importance of contact, dialogue, and ensuring that it is not a *"cold"* technology. In our study, they recognize that technology does not replace people, but it can be a realistic solution to loneliness.

The reference to telecare as a positive model was repeated in several interventions, as it combines technology with empathy and emotional availability.

"A little more human contact [...] more interaction with us."
"When something happens, I say, 'Oh my God...' but you can't burden your neighbors with your problems."

3.1.7 Perceived barriers and economic sustainability

In general, few technical barriers are perceived with the new system. Previous complaints (adhesives, moisture failures) are not repeated with *Microchip4Age.* However, economic sustainability does appear to be a real concern.

When asked, *"Would you buy this technology?"*, most responded affirmatively, but conditional on price and maintenance. The comparison with services such as telecare was useful in understanding how much they are willing to pay. The final cost of the technologies and the ability to maintain them in the long term are key factors for their continued use among older adults [Hawley-Hague et al., 2014].

"The old devices kept disconnecting, but from what we've seen, these don't."
"Our future is to be alone, so at least we should have technology to help us."

3.2 Quantitative results

This section presents the results obtained from the analysis of the questionnaire completed by the students, including their sociodemographic profile, previous experiences, and perceptions of *Microchip4Age* technology in the social and healthcare context.

The quantitative part of the study consisted of a total of 18 participants, with an average age of 27. The sociodemographic profile and main perceptions of the sample are detailed in Table 1. As shown, the profile was predominantly female, representing 94.4% (n=17) of the participants, while 5.6% (n=1) were male. This female predominance reflects a structural trend in the social and healthcare field, characterized by a strong feminization in disciplines such as Social Work, Nursing, and Psychology, making it a representative profile of the training and professional sector targeted by this study.

Characteristic	Percentage (n)
Gender	
Female	94.4% (17)
Male	5.6% (1)
Previous training	
Social/healthcare fields	83.3% (15)
Other areas	16.7% (3)
Work experience in the sector	
No experience	61.1% (11)
With experience	38.9% (7)
Privacy sufficient without cameras/microphones	
Yes	61.1% (11)
Depends on context	27.8% (5)
Main advantage	
Risk prevention	100% (18)
Peace of mind for family	94.4% (17)
Design personalization	
Fully customizable	72.2% (13)
Main barrier	
Economic cost	41.2% (7)
Mistrust among older adults	23.5% (4)

Table 1: Profile and perceptions of participants (n=18)

As detailed in Table 1, most participants had previous training in social and healthcare disciplines, such as social work, psychology, or nursing (83.3%, n=15), and 16.7% (n=3) came from areas such as administration, economics, or law. In terms of work experience in the social and healthcare field, 61.1% (n=11) had not worked in this sector, while 38.9% (n=7) did have experience in settings such as nursing homes, associations, or home care services, performing coordination, social work, psychology, or administrative duties.

Regarding privacy and intimacy, 61.1% (n=11) considered that the absence of cameras or microphones is sufficient to guarantee privacy. However, 27.8% (n=5) pointed out that this assessment would depend on the context. The qualitative responses to the questionnaire highlighted the importance of informed consent, transparency in the management of personal data, and the possibility of customizing the level of control, aligning with the concerns expressed in the discussion group.

Regarding protection and autonomy, 100% (n=18) of students identified the prevention of risks such as falls or situations of isolation as the main advantage, while 94.4% (n=17) valued the peace of mind it offers to family members. Likewise, the system's ability to provide real-time information and enable a rapid response was

highlighted, aspects perceived as facilitating personal autonomy without compromising individual freedom.

In terms of design and adaptation, 72.2% (n=13) considered that the technology can be fully customized to the user's profile, which facilitates its integration into everyday life without generating rejection. This result is consistent with the students' assessment of the design as discreet, comfortable, and non-stigmatizing.

In terms of perceived barriers, economic cost was identified as the main obstacle to the implementation of this technology (41.2%, n=7), followed by mistrust among older adults (23.5%, n=4). These perceptions coincide with the concerns expressed about economic sustainability and social acceptance.

Finally, in relation to the emotional dimension and human support, although the questionnaire did not directly address this aspect, several qualitative responses emphasized that technology should be a complement to, not a substitute for, human care. The importance of integrating these systems into a care model that combines innovation with warmth and interpersonal contact was highlighted.

4 Discussion

The main findings show a largely favorable attitude toward the implementation of non-invasive monitoring technologies among older adults and future professionals in the social and healthcare field. However, this acceptance is not unconditional: it is deeply influenced by factors such as perceptions of privacy, technological accessibility, economic sustainability, device aesthetics, and the need for human support. These elements should strategically guide the design, implementation, and scaling of these devices in real care settings.

One of the most significant contributions of this work is the empirical validation of “non-invasive” nature as a determining factor in the acceptance of technologies by older adults. This attribute is understood not only as the absence of cameras or microphones, but also as a respectful, subtle, and non-intrusive form of care. Participants valued the possibility of feeling protected without feeling monitored, which reinforces the idea that technology should be integrated into everyday life without altering the user's autonomy or public image. This assessment coincides with previous studies [McNeill et al., 2017; Pinazo-Hernandis, 2024], which highlight the need to redefine technological design from an ethical, emotional, and person-centered perspective. A relevant pattern that emerges from the comparison between the groups is that, while older adults particularly valued discretion and the non-replacement of human contact, future professionals emphasized the usefulness of social and health care and integration into person-centered care models. This divergence reinforces the need to design technologies that balance safety and autonomy, and underscores the importance of including both groups in co-creation processes.

Microchip4Age devices were well received due to their discreet, lightweight, and aesthetically neutral design, which facilitated their acceptance by avoiding visual rejection or stigmatization. Ease of use and harmonious integration into the home environment were key elements in their positive assessment. These findings reinforce the importance of person-centered design as a facilitator of adoption, in line with the principles of universal design and active aging [Pérolle & Etxeberria, 2006].

On the other hand, both older adults and future professionals insisted on the need for transparency, trust, and control over the personal data collected by the devices. The fear of being observed, or uncertainty about who accesses the information, appear to be significant barriers that can limit acceptance, especially in a context where informed consent and respect for privacy are fundamental values. This concern poses significant challenges in terms of ethical data governance and requires the implementation of clear protection systems, accessible communication, and active participation in decision-making.

At this point, it is essential to emphasize that ethical consent must be adapted to the reality of older adults with low digital literacy, ensuring that they understand how the system works, the type of data it collects, and the implications of its use. This involves developing simple, accessible, and multimodal information materials (text, audio, practical examples), as well as support spaces where questions can be answered before final acceptance. This type of ethical and participatory approach has recently been proposed by LaRubbio et al. [2025], who argue that artificial intelligence systems intended for older adults should be designed from the outset with the direct participation of users. Trust in AI-based systems depends largely on factors such as transparency and clarity in the use of data [Tun et al., 2025].

From the perspective of older adults, trust is built not only with reliable technology, but also through human support, clear explanations of how the system works, and a perception of real usefulness. These elements are directly aligned with the principles of PCC [Rodríguez, 2013], which promote respect for individual wishes and preferences and active participation in care plans. In this sense, technology is seen as a complement, not a substitute, for human care, capable of providing monitoring and security without compromising dignity or self-determination.

The emotional component also emerged as a critical aspect. Although older adults valued the usefulness of the system, many expressed that technology must always be accompanied by human contact and emotional relationships. This finding, also reported in previous research [Andersson et al., 2017], underscores that the digitization of care cannot and should not replace human connection, but rather reinforce it.

From the perspective of participating students, the quantitative results reflect a positive assessment of technology in aspects directly related to the experience of older adults: reinforcing autonomy, a sense of security, risk prevention, and the possibility of integration into person-centered models. Some 88.9% of students expressly linked it to the PCC model, reinforcing its alignment with a care philosophy based on respect, participation, and personalization of care.

Barriers consistent with those expressed in the discussion group were also recognized: the economic cost and the possible mistrust of older adults. As solutions, complementary strategies were proposed, such as staff training, raising awareness among users and families, and the possibility of conducting pilot tests, highlighting a proactive approach committed to the ethics of care.

A particularly relevant point is the role of the home as the preferred space for the application of these technologies. Older adults showed a clear preference for aging in their usual environment, provided that support measures are in place to reinforce their independence and well-being. *Microchip4Age* technology responds to this objective, enabling aging in place with greater safety and autonomy, in line with the international recommendations of the WHO [2020] and European policies on active aging.

Finally, in ethical terms, participants agreed that the absence of cameras and microphones is a necessary first step, but not sufficient. They insisted on the need for consent to be informed, voluntary, and revocable, as well as on the importance of adapting the installation to personal preferences, including the possibility of limiting the technology to certain spaces, times, or functions. This requires flexible, customizable implementation based on deep respect for each person's uniqueness. In this sense, co-creation is presented as a methodological innovation and a differential value, as it allows older adults to be integrated into the design and technological validation process, favoring solutions that are more in line with their expectations, contexts, and real needs. In addition, this collaborative working model ensures greater social and ethical legitimacy in the implementation of the systems.

Based on these findings, practical recommendations can be derived. For designers, it is suggested that they prioritize transparency in the use of data, include customization options, and avoid any aesthetic stigmatization. For healthcare managers and policymakers, it is recommended that they consider subsidy mechanisms or public funding to reduce economic barriers and facilitate equitable access. For social and healthcare professionals, it is crucial to receive training that allows them to integrate these technologies into person-centered care models without losing human contact. Future lines of research should include longitudinal studies, the perspective of formal caregivers, and cost-effectiveness analyses in real-world implementations.

In conclusion, the findings of this study can be extrapolated and adapted to different cultural and economic contexts, opening opportunities to apply the Microchip4Age experience in other countries or regions with diverse social realities, provided that the principles of participation, flexibility, and equitable access are upheld.

4.1 Limitations of the Study

This study has several limitations. First, it does not include a longitudinal assessment of sustained use of the devices in real-world settings. Although the results provide an initial insight into perceived acceptability, future research should incorporate prolonged experiences of use, implement the system in a wider range of settings, and gather the perspectives of other stakeholders and professionals involved in social and health services. Second, the small size and non-probabilistic nature of the quantitative sample limit the statistical generalizability of these results. Future studies should expand the sample to confirm the observed trends.

Third, the study was conducted within a specific sociocultural context (Southern Spain). Cultural attitudes towards technology, aging, and privacy, as well as socioeconomic factors and the structure of public healthcare systems, may influence the acceptance and feasibility of such monitoring systems in other regions. This contextual limitation suggests the need for future comparative studies across different cultural and economic settings to assess the transferability of these findings.

5 Conclusion

The current work and the results of this study provide a comprehensive view that combines the perspectives of those who will receive care with those who will manage it. They reveal that the acceptance of social and healthcare technologies does not depend solely on their technical effectiveness, but also on their suitability to the ethical,

emotional, cultural, and relational dimensions of care. To achieve successful implementation, technology must be co-created with older adults, respecting their values, promoting their autonomy, and recognizing their active role in building more humane, accessible, and empathetic solutions.

The results indicate a high level of acceptance of non-invasive monitoring technologies, provided they align with the principles of Person-Centered Care. Factors such as privacy, discretion, accessible design, ease of use, and human support emerge as determinants in their positive assessment. The effective implementation of these solutions requires transparency in data management, customization capabilities, and careful integration into everyday life, as a complement—not a substitute—for human care. The social and healthcare innovation of the future cannot be conceived without listening to the voices of those who are, ultimately, its protagonists.

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