

# Ethical and Social Aspects of Ambient Assisted Living in Croatia as Perceived by the Elderly, Nurses and Engineers: A Qualitative Study

Terezija Gložinić<sup>1</sup>, Anto Čartolovni<sup>2</sup>, Odilon-Gbènoukpo Singbo<sup>3</sup>

<sup>1</sup>University Department of Nursing  
Catholic University of Croatia  
Zagreb, Croatia

Terezija Gložinić  
[tglozanic@unicath.hr](mailto:tglozanic@unicath.hr)  
ORCID: 0000-0002-0219-756X

<sup>2</sup>Digital Healthcare Ethics Laboratory  
(Digit-HeaL)  
Catholic University of Croatia  
Zagreb, Croatia

Anto Čartolovni  
[anto.cartolovni@unicath.hr](mailto:anto.cartolovni@unicath.hr)  
ORCID: 0000-0001-9420-0887

<sup>3</sup>Chair of Theology  
Catholic University of Croatia  
Zagreb, Croatia

Odilon-Gbènoukpo Singbo  
[odilon.singbo@unicath.hr](mailto:odilon.singbo@unicath.hr)  
ORCID: 0000-0002-2154-8935

## Corresponding author:

Terezija Gložinić  
Catholic University of Croatia  
Ilica 242, 10 000 Zagreb, Croatia  
[tglozanic@unicath.hr](mailto:tglozanic@unicath.hr)

## Abstract

**Background:** One of the major problems affecting the Western world is the rising increase of the elderly population. Consequently, society is looking to develop care and support systems for the elderly. Technological systems are being developed that aim to improve the quality of life of older people in order to afford them independence and autonomy. One such tool is Ambient Assisted Living (AAL), which implements various technologies into the homes of the elderly, contributing to their safety. The use of such technologies may lead to various social or ethical problems.

**Aim:** The aim of this study was to analyze the social and ethical issues of AAL and to understand the perceptions of the stakeholders in Croatia (the elderly, nurses and engineers) in detail.

**Methods:** We conducted qualitative research through semi-structured interviews with 17 participants from Croatia among three categories of people who could be potential stakeholders in the AAL system: nurses, engineers and the elderly. The interviews were recorded and then transcribed. The thematic analysis method was used to analyze the data.

**Results:** A total of five nurses, six engineers, and six elderly individuals were interviewed. This study showed that there is a need to use AAL technology to improve the care and quality of life of the elderly. The participants were concerned about the potential of such technology to deprive the elderly of important human components of care, such as interpersonal warmth and touch, which might result in social isolation. The ethical issue of privacy breach due to constant video surveillance was a concern expressed by all the participants.

**Conclusion:** The greatest concerns regarding AAL found in this study were a lack of human contact, i.e., dehumanization of care, and the threat to privacy due to data collection using sensors and video surveillance.

**Keywords:** Ambient Assisted Living, smart homes, privacy, human contact, ethics, social isolation

## Introduction

The development of medicine and medically assisted technologies undoubtedly represents a great opportunity and advantage (1), as it provides new insights into various health fields, especially with regard to aging and the applications of gerontechnology based on artificial intelligence (AI) (2). The application of technology along with a special diet—through a general healthy lifestyle and behavior—have contributed to an improvement in the quality of human life, but also to extending life expectancy significantly. This increase in longevity has consequences. The most important is an aging population, which poses a complex challenge (3), especially in the Western world. The United Nations' document *World Population Prospects 2022, Summary of Results*, projects that by 2050 one in every four persons in Europe and North America could be aged 65 years or over (4).

Such data imply various challenges that society must deal with effectively (5). There are economic (6), social and health repercussions: increased financial pressure on healthcare systems due to the growing number of the elderly prone to various age-related diseases, declining birth rates alongside increased mortality, creating a gap in population demographics and dynamics (3). There is also an underdeveloped care network for the elderly and a general lack of support, which is especially notable in Croatia, as well as many parts of Central and Eastern Europe. In some countries, institutional care for the elderly is still prevalent (nursing homes) (7). In the more developed countries of the Western world, care focuses on keeping the elderly in their own homes through gerontechnology, i.e., intelligent building systems (8).

In that vein, ideas and technological systems based on ambient intelligence (AmI) are being developed. Ambient Assisted Living (AAL) includes the use of ambient intelligence-based techniques, processes, and technology with the intention of enabling older people to live independently and maintain their quality life for as long as possible (9). This involves sensors, cameras and robotic systems of various types being

installed in the living environment of the elderly. More specifically, the concept of *smart homes* most precisely describes the implementation of AAL in the lives of older people, i.e., in their residences (10). Due to efficient networking and connectivity, most often with smartphones, Wi-Fi network (the Internet of Things), caregivers or healthcare professionals can receive feedback through applications and software, especially in an emergency. An example of such aids are fall sensors that work by monitoring floor pressure and using this information to report on the user's condition to families or healthcare providers.

Such technologies are intended to enable the elderly to age well and with dignity in the comfort of their own homes, with a reduced dependence on others. They are used as preventive measures, as well as treatment and improvement tools to aid the well-being and health status of the elderly. The European Union has recognized the importance of developing such technologies and has listed objectives to be achieved through such programs: a) independent living in the desired environment; b) continuous health monitoring; c) avoidance of social isolation; d) improved security and privacy and e) promotion of smart systems for a better quality of life (11).

However, if we look at how technology is evolving, it is difficult to remain neutral concerning its use in this regard, that is, to adopt the view that it all depends on the way the technology is used. It is also erroneous to idealize technology as the only new form of salvation for humankind. All use of technology is an intentional activity that takes place in a specific social environment and establishes dialogue with various values and themes, domains, disciplines, environments and fields (12). Therefore, in addition to the technical specifications of AAL, it is important to observe its impact on individuals and society. The ethical issues raised according to the Royal Academy of Engineering (13) are as follows: Is social isolation the price to be paid for the autonomy provided by smart homes? How can a balance be maintained between independence and sociability (connectedness with others)? Will vulnerable

groups, such as the elderly, understand the nature of technologies in smart homes, and how can we ensure that they have given clear informed consent about their use? Who should control the data generated by systems that “supervise” people’s movements and “oversee” their physical condition? Some of the social and ethical issues associated with AAL and smart homes are the threat to privacy, concerns about surveillance and control, questions of availability, the dangers of (or problems associated with) an over-reliance on technology, as well as a lack of human contact. In summary, by endeavoring to use technology to target 4P medicine (predictive, personalized, preventive and participative), there is a danger of creating the so-called 4Ds: depersonalized, discriminatory, dehumanized and disciplining (2). The results of a literature search show that no research on this topic has been conducted yet in Croatia, so for a deeper understanding of the social and ethical issues related to this topic, one should begin from the perspective of those who may be directly or indirectly involved in using AAL. To this end, our study aimed to analyze the social and ethical issues associated with AAL and achieve a detailed understanding of the perceptions of the stakeholders in Croatia (the elderly, nurses and engineers).

## Materials and method

### *Study design*

A qualitative study was conducted by means of semi-structured interviews. Different issues were devised for each category of participants.

### *Ethics*

The study was conducted in accordance with the institutional Codes of Ethics. All methods were performed in accordance with the relevant guidelines and regulations. Written informed consent was obtained from all the study participants.

The study protocol was approved by the Ethics Committee of the Catholic University of Croatia (document number 498-03-02-06/1-21-04).

### *Participants and data collection*

The participants were selected by snowball sampling. Seventeen interviews were conducted with 3 categories of participants: nurses (N=5), engineers (N=6) and the elderly (N=6). The first stage of the study was conducted from March to May 2021 in the Republic of Croatia and included 11 people. The second stage was conducted from January to February 2023, with an additional 6 people in the same country. The interviews lasted from 10 to 30 minutes. Some of the participants (N=9) were contacted online via the Zoom app, while others (N=8) were interviewed in person, at home or in the workplace. In this article, the participants were coded: N (nurse), OP (older person), E (engineer). The ordinal number of a participant was added to the abbreviation, for example, N1, OP2, E3. Inclusion criteria for the elderly were age (>65 years) or retirement. The nurses were required to be employed with outpatient duties (district nursing), working directly with the elderly. The engineers were from the fields of electrical engineering and information technology, and had some experience with AAL. The thematic analysis method was used to analyze the data. The obtained themes were divided into 3 categories, as presented in the results section.

## Results

Thematic analysis of the results yielded three categories of themes: 1. acceptance and availability of AAL technologies, 2. loss of human contact, 3. data collection, privacy vs. safety.

### **1. Acceptance and availability of AAL technologies**

Our study on AAL shows that nurses who made daily visits to elderly people with chronic illnesses and entered their homes expressed a level of concern regarding the physical maladaptation of apartments and the inability of the elderly to maintain their quality of life due to limited mobility. They highlighted the problem of the social isolation faced by many elderly people.

*"There are a lot of practical impediments for older people. They remained in the spaces where they had lived as young people, and they hadn't thought about the fact that they would need to address those challenges" (N2).*

Due to these problems, the nurses reported that their patients would benefit from using AAL technologies. The engineers, but also nurses, pointed out that introducing such technologies into the homes of the elderly would improve their quality of life but also help facilitate the work of the health professionals involved in their care.

Depending on the circumstances in which the elderly lived or the characteristics of their apartments, they were asked whether they would be interested in using a smart home system if it were offered. Some participants answered in the affirmative, recognizing the benefits that such technologies would bring to their lives, while one participant recognized the benefits of AAL technologies, responding as follows:

*"Yes, I am interested. I'm very alone in the house. I would be very glad to have it [AAL]" (OP2).*

One of the key problems recognized by the nurses, which concerns the challenges that AAL system users could face, is the insufficient acceptance and use of technology by their elderly patients. The technologies they use are mostly cell phones, which are not always smartphones, and televisions. The nurses' statements reveal that the elderly they encounter do not use other technologies in their apartments and are not inclined to use, or open to, technology:

*"Mostly, they use cell phones, and usually their family puts it on speed dial. They are mainly connected to phones, TV and that's all" (N1).*

The older people themselves considered the same issues regarding the use of some of the technologies, but they expressed disinterest more often than enthusiasm:

*"I'm not exactly for modern technology; I don't even use a computer, only a cell phone. I don't use a smartphone but only a classic one because, I admit, it doesn't really interest me much. I am more practical and prefer face to face, one on one [interactions]" (OP3).*

Acceptance of technology has been shown to be linked to technological literacy. Participants identified the reasons for the non-acceptance and non-use of technology as insufficient technological information as well as literacy, associated with difficulties in keeping up with technology. There was a distinctly divided view on the issue of technological literacy, on one hand believing that the elderly are not technologically literate at all (N1, 3, 4 & 6), and on the other that literacy is an individual matter, and that it is erroneous to generalize about the technological illiteracy of the elderly population as a whole (N2 & 5). Engineers, on the other hand, indicated that it is possible to offer technology to older people in an acceptable manner (E6). Therefore, ways must be found to develop technology that can be adapted to the capabilities and technological literacy of the end users, in this case, the elderly.

*"I think that somehow everything needs to be adapted, [so] that there is the same critical mass of older people who can adapt to technology. Since not everyone is incompetent, those who are less able will use the smaller range of the technologies that are accessible to them" (E1). "There should be ways to make technological advances more accessible to the elderly, but again those who want them will accept them, and those who do not, will not. It's just a matter of will" (E2).*

Another dimension of the social problem of AAL technologies is undoubtedly economic. The engineers addressed this point. One of the engineers emphasized cost as the primary disadvantage of AAL technology. Considering the financial status of many retired people in Central and Eastern Europe, especially in Croatia, the participants assumed that older people would neither want nor be able to spend large amounts of money for technology that they often view as a luxury:

*"Very often we realize that many of them have saved money but don't want to spend it on improving their quality of life. If we were to suggest that, they would immediately respond: How much does it cost?" (E1)*

With regard to the financial (in)accessibility of AAL technologies to the public, several

of the participants considered AAL systems to be extremely expensive currently but indicated it was worthwhile to invest in such technology if there is the will to do so (E5 & 6). One engineer reported that such technologies can be accessible to the general public because of the many do-it-yourself solutions:

*"I think that such technologies are financially accessible to the general public. Fifteen years ago I would have said that they were not, now I would say that they are because you have a lot of smart home solutions that are based on do-it-yourself and you can do a lot of things for quite little money" (I2).*

## 2. Loss of human contact

The use of AAL inevitably entails certain ethical issues that should not be ignored. They are perhaps more important than the prominent social issues because they concern humanity itself in its encounter with technologies, privacy management, (i.e., user data) and the future of the biomedical profession. Therefore, the first ethical challenge of AAL technologies, which was touched upon during conversations with all the participants, is the loss of human contact. Recognizing human warmth as an essential component of the nursing profession, nurses consider a lack of human contact to be detrimental, with a risk of negative consequences for the elderly. They emphasized the importance and necessity of human contact in their profession, observing that technology cannot completely replace humans, i.e., the human component in their profession, but also more generally in all human relationships.

*"We need to look at technology as an auxiliary aid, but it can never replace us, and it can't replace humanity. It can't replace proximity and touch" (N3).*

One nurse was more optimistic about the future of the nursing profession. According to her, these technologies will allow them to *"focus on much more important things – wound bandaging, care, hygiene, psychological help and communication with the patient. I would spend*

*more time communicating with the patient because it means a lot more to them, and now I must do physical tasks that are strenuous and don't mean too much to them. They miss social interaction" (N5).*

The nurses' views are in accordance with the attitudes of the older people, who agreed that technology cannot replace human interaction, especially in terms of medical care. In that vein, the engineers also indicated that technology entails some consequences for human communication. Like the nurses, they reported that technology should be viewed as an aid but by no means as a substitute for real human contact and communication. All agree that regardless of the efficiency and advantages that new technology offers, it should remain an auxiliary tool and not a replacement for human interaction. *"It should by no means replace that interaction with people completely. Someone should always come to visit a person; check how they are doing. This is just support and should certainly not completely replace interaction. It should instead encourage people to meet and spend time together again, knowing that the time not spent together, thanks to technology, ensures a better quality of life" (E3).*

For one nurse, there is the danger that technology will take over:

*"The technology could in some ways make things worse because the elderly still have some physical requirements. Those who may be more mobile can go to the bank to withdraw cash and may meet a neighbor and exchange a few words. Technology could in some ways tie them even more to the house" (N4).*

The practical aspects of using AAL as an aid for the elderly include various robotic devices and digital assistants to help with daily activities, but also to help perform some medical procedures that are otherwise practiced by nurses. Interestingly, nurses are not in favor of introducing robots as a substitute for medical staff. This is primarily due to the inability of robots to communicate constructively or express human warmth. Regarding the possibility of robotic care replacing a nurse or physiotherapist, the concerns of the elderly focused on

communication, human warmth and the importance of human touch, i.e., human interaction.

*"I love seeing them. I love their touch. I love hearing their voices. I don't know how I would feel; I can't even imagine it. I don't know how a robot would rub my arm. This is the biggest failing (or deficiency) of technology: the lack of human contact. If a robot showed a little emotion, I would allow it to do everything"* (OP2).

*"I want contact with others. Such technology would not prevent me from being in touch with others"* (OP5).

A similar opinion is shared by OP6, while one elderly person alluded to the spiritual dimension of contact, claiming:

*"I would not accept a robot. I don't need anything without a soul. I don't see any advantage in that"* (OP4).

### 3. Data collection, privacy vs. security

AAL uses AI and AmI. Certain user data must be collected to ensure the optimal functionality of the system for the user. Data collected by the system are mostly personal, so some of the engineers emphasized possible data misuse as an ethical issue.

*"For that reason, it should be accepted as a support in your daily life but understood that in return some personal information must be collected"* (E3).

Two (E2 & 5) of the engineers emphasized that they had never considered the ethical issues that might arise. However, all the engineers were of the same opinion that the use of data, even the possibility of manipulation and misuse, depends on who coordinates the system and manages the data. An interesting observation was made by one participant who underscored the importance of vetting any prospective company prior to contracting them to check for any prior data breaches or misuse of personal data. The engineers emphasized that the quantity and nature of the data collected were valuable, as they enabled the system to function more effectively. However, the nature of valuable data makes them subject to manipulation

and abuse. For this reason, the importance of legal frameworks for AAL technologies was stressed. It was agreed that such issues touch upon the legal implementation of the General Data Protection Regulation (GDPR). The engineers emphasized the need for some form of contract to be signed between the user and service provider to minimize data misuse and ensure informed consent:

*"In my opinion, there are already many laws, such as the GDPR laws, but also others, I believe, that regulate the modification and exchange of such data, any data, about an individual. Clearly, companies that develop such laws would be legally subject to them and any data abuse or mismanagement would be subject to criminal liability. Issues outside such regulations could be addressed with separate direct contracts, agreements between the provider and the end user. These issues would have to be agreed upon and signed"* (E1).

In short, the possibility of data misuse exists.

As there is no effective and comprehensive application of AAL technologies without placing cameras in apartments to achieve increased security, elderly individuals stressed that they would feel (extremely) uneasy under video surveillance. Nevertheless, most indicated that the issue of 24-hour surveillance should be solely a matter of personal choice, but over time most people would get used to it.

*"I hold that it would be positive, but I think it would take time for a person to get used to it. You would feel like someone was following you all the time. It might be discomforting at first, but I think it would eventually be okay"* (OP3).

Some of the engineers agreed on this issue, considering it unacceptable to incorporate in-home video surveillance.

*"I would say anything other than video is acceptable. If it's a person's location, if it's alarms, that's all fine as long as you don't have constant video footage of the person, if it's not necessary"* (E2).

They cited the need for privacy in the home:

*"I wouldn't want to have cameras because at least at home I would like to have some privacy"* (E4).

One of the major ethical issues associated with AAL technologies directly concerns the threat to user privacy. One nurse referred to the elderly's desire for their own intimacy, privacy, ability to remain in their own home and the fact that video surveillance might endanger precisely that which they considered most important.

*"I think it would help, in terms of family, to follow and supervise them, but it would deprive them of their privacy. That's exactly why they want to be in their own home. They don't go into [sheltered] accommodations; they want to live their own lives. Surveillance eliminates that" (N2).*

One of the engineers also emphasized the right to privacy. However, the participant cited the threat to privacy as the price to pay for using AAL technologies. He noted that everyone needs to assess what the advantages and disadvantages are, bearing in mind the price of security.

*"I believe that one of the major ethical issues is certainly encroaching on someone's privacy. Everyone has the right to keep their life within*

*their own four walls. However, if you want to take care of someone vulnerable, certain boundaries may need to be crossed" (E3).*

These attitudes of the engineers and nurses lead us to the key ethical issue: the choice between security and privacy. Considering that a primary goal of AAL is to provide security for the elderly, and to achieve this may entail a sacrifice of one's privacy, the participants were asked whether privacy or security should be prioritized for the elderly. The nurses opted for privacy, while a participant from the group of elderly people opted for safety. Three engineers responded that this should be an individual decision, depending on the pros and cons of surveillance for each individual. For the elderly, the advantage is safety:

*"I hold that safety is more important. Privacy is of course important, but to an older man security means a lot" (OP3).*

*"A feeling of security is an advantage, and I don't see any particular downsides, maybe others would make fun of me" (OP5).*

Theme	Subtheme	Quotes
Acceptance and availability of AAL technologies	Maladaptation of apartments	<i>"There are a lot of practical impediments for older people. They remained in the spaces where they had lived as young people, and they hadn't thought about the fact that they would need to address those challenges" (N2).</i>
		<i>"Yes, I am interested. I'm very alone in the house. I would be very glad to have it [AAL]" (OP2).</i>
	Technological illiteracy	<i>"Mostly, they use cell phones, and usually their family puts them on speed dial. They are mainly connected to phones, TV, and that's all" (N1).</i>
		<i>"I'm not exactly for modern technology. I don't even use a computer, only a cell phone. I don't use a smartphone, only a classic one because, I admit, it doesn't really interest me much. I am more practical and prefer face to face, one on one [interactions]" (OP3).</i>
	Economic aspects	<i>"Very often we realize that many of them have saved money but don't want to spend it on improving their quality of life. If we were to suggest that, they would immediately respond: How much does it cost?" (E1).</i>
		<i>"I think that such technologies are financially accessible to the general public. Fifteen years ago I would have said that they were not; now I would say that they are because you have a lot of smart home solutions that are based on do-it-yourself and you can do a lot of things for quite little money" (I2).</i>
	Adaptation for end users	<i>"I think that somehow everything needs to be adapted, [so] that there is the same critical mass of older people who can adapt to technology. Since not everyone is incompetent, those who are less able will use a smaller range of technologies that are accessible to them" (E1).</i>
		<i>"There should be ways to bring technological advances more accessible for the elderly, but again those who want them will accept them, and those who do not, will not. It's just a matter of will" (E2)</i>

<b>Data collection, privacy vs. safety</b>	Dehumanization of care	<i>"We need to look at technology as an auxiliary aid, but it can never replace us, and it can't replace humanity. It can't replace proximity or touch" (N3).</i>
		<i>"It should by no means replace that interaction with people completely. Someone should always come to visit a person; check how they are doing. This is just support and should certainly not completely replace interaction. Instead, it should encourage people to meet and spend time together again, knowing that the time not spent together thanks to technology ensures a better quality of life" (E3).</i>
	Robotic care	<i>"The technology could in some ways make things worse because the elderly still have some physical requirements. Those who may be more mobile go to the bank to withdraw cash and may meet a neighbor and exchange a few words. Technology could tie them even more to the house in some ways" (N4).</i>
		<i>"I love seeing them. I love their touch. I love hearing their voices. I don't know how I would feel; I can't even imagine it. I don't know how a robot would rub my arm. This is the biggest failing (or deficiency) of technology: the lack of human contact. If a robot showed a little emotion, I would allow it to do everything" (OP2).</i>
<i>"I want contact with others. Such technology would not prevent me from being in touch with others" (OP5).</i> <i>"I would not accept a robot. I don't need anything without a soul. I don't see any advantage in that" (OP4).</i>		
Positive perceptions	<i>"Focus on much more important things – wound bandaging, care, hygiene, psychological help and communication with the patient. I would spend more time communicating with patients because it means a lot more to them, and now I must do physical tasks that are strenuous and don't mean too much to them. They miss social interaction" (N5).</i>	
<b>Data collection, privacy vs. safety</b>	Data collection	<i>"For that reason, it should be accepted as a support in your daily life but understood that in return some personal information must be collected" (E3).</i>
		<i>"In my opinion, there are already many laws, such as the GDPR laws, but also others, I believe, that regulate the modification and exchange of such data, any data, about an individual. Clearly, companies that develop such laws would be legally subject to them, and any data abuse or mismanagement would be subject to criminal liability. Issues outside such regulations could be addressed with separate direct contracts, agreements between the provider and the end user. These issues would have to be agreed and signed to" (E1).</i>
	Video surveillance	<i>"I hold that it would be positive, but I think it would take time for a person to get used to it. You would feel like someone was following you all the time. It might be discomforting at first, but I think it would eventually be okay" (OP3).</i>
		<i>"I would say anything other than video is acceptable. If it's a person's location, if it's alarms, that's all fine as long as you don't have constant video footage of the person, if that's not necessary" (E2).</i>
		<i>"I wouldn't want to have cameras because at least at home I would like to have some privacy" (E4).</i>
		<i>"I think it would help, in terms of family, to follow and supervise them, but it would deprive them of their privacy. That's exactly why they want to be in their own homes. They don't go into [sheltered] accommodations; they want to live their own lives. Surveillance eliminates that" (N2).</i>
Privacy vs. safety	<i>"I believe that one of the major ethical issues is certainly encroaching on someone's privacy. Everyone has the right to keep their life within their own four walls. However, if you want to take care of someone vulnerable, certain boundaries may need to be crossed" (E3).</i>	
	<i>"I hold that safety is more important. Privacy is of course important, but to an older man security means a lot" (OP3)</i>	
	<i>"A feeling of security is an advantage, and I don't see any particular downsides, maybe others would make fun of me" (OP5).</i>	



## Discussion

Our study, unique in the context of Central Eastern Europe, more precisely Croatia, reveals the participants' expectations and concerns. The importance of this research lies in the confrontational dynamic involving the key strata of those societies affected by AAL. The most prominent components concern the real need for AAL technologies, the interest of the elderly in technology, the cost-effectiveness of AAL technologies, the loss of human contact and privacy issues.

### The challenge of aging and accompanying difficulties

Undoubtedly the biggest problems faced by the elderly include social isolation and loneliness, further exacerbated by a diminishing quality of life, reduced financial income, loss of independence and feelings of insignificance due to the familial obligations of their kin. A 2020 report by the National Health and Aging Study, prior to the COVID-19 outbreak, found that 24% of persons aged 65 and over in the United States (approximately 7.7 million people) were socially isolated (14). In our study, the elderly and nurses referred to social isolation during the COVID-19 pandemic when people were advised to avoid meeting the elderly for their safety, further increasing their social isolation and loneliness. In Japan, such living conditions for the elderly have led to the *Kodokushi* phenomenon (15), so-called "lonely" death, i.e., the undignified deaths of elderly people living in social isolation. Questions pertaining to feelings of isolation and loneliness inevitably require solutions from technology. Nakazawa and others emphasize the invaluable role that wearable devices can play in monitoring an elderly individual's health, thus enabling a timely response to any crisis.

Wearable devices and other AAL technologies can indeed contribute significantly to independence, but problems with lack of interest in technological assistance may arise. However, those surveyed generally did not exhibit an aversion to or disinterest in assistive technology, although the nurses interviewed reported disinterest

shown by the patients they visit. This is understandable, given that such technology is a relatively recent development. It should be emphasized that an understanding of older people's perception of technology is crucial. Comprehensive explanations should be provided and technological literacy encouraged to help foster acceptance of technology's role in helping to create an easier and more independent life (16).

In this regard, technological literacy, i.e., the ability to understand, evaluate, use and manage technology, is crucial. Those with minimal life experience using technology have little or no technological literacy, making it difficult for them to use it later in life and posing challenges for its application in the home (17). The issue of technological literacy is clearly an individual matter. Namely, technological awareness among the elderly has been growing in tandem with advances in technology. In 2013, 18% of the elderly population (65+) in the United States used smartphones, while in 2017 that number climbed to 42% (18). Consequently, an increase in technological literacy and the use of technology among the elderly can be expected, which is certainly fertile ground for the application of AAL technologies in order to help maximize independence (19). It should be noted that there is a lack of awareness of the latest technologies that may increase independence at-home. Often marketed, sometimes at high cost, under the comfort or entertainment category, there is often public ignorance due to insufficient emphasis on the benefits of those technologies.

Another obstacle to introducing smart home technologies into the lives of older people is their cost effectiveness. Opinions are divided: namely, some respondents indicated that it was possible to find alternative do-it-yourself AAL products. Numerous studies (20–24) show otherwise. The results of a study by Pal et al. reveal cost to be the most significant predictor for refusal to use smart home technologies (20). Leaders at the national and international levels could play a more prominent role in promoting the benefits and adoption of smart homes by offering tax exemptions and other such policies to incentivize companies.

### **AAL trial ethics**

The primary ethical concern regarding use of AAL technologies was the loss of human contact (25). Some authors (26) warn that new technologies may have a dehumanizing effect on human relationships. The elderly study participants posited similar views, i.e., that robots cannot replace the “human touch” in health care. There was a general agreement that, regardless of technology’s efficiency and advantages, it should remain an aid and by no means replace humans. Human warmth, touch and supportive discourse were all considered to be important to the respondents. It is necessary to retain cautious optimism about the promises of the new technologies. They should remain aids, not substitutes, for traditional forms of human contact. AI must not exceed the fundamental values or appropriate aspects of care that only human beings can meaningfully perform. AI’s task is to support, improve and create opportunities for the medical profession to provide the unique human aspect of care (27). Although technology can help reduce social isolation in the elderly, there is a real danger that avoidance of human contact risks further increasing such isolation.

Another important ethical issue raised by the participants concerns privacy. There is no doubt that the collecting and processing of enormous quantities of data by AAL systems risk compromising user privacy. This especially applies to data collected by cameras and video surveillance. We consider the threat to privacy to have a significant effect on the likelihood that the elderly will refuse to use smart homes, as previously confirmed by Koimizu et al. (28). Many other studies have also shown that privacy is one of the main concerns about technology such as AAL (29). These concerns were also raised by the nurses in our study. They believe that the privacy of the elderly is really at risk. At this vulnerable time in their lives, the elderly want to stay in their own homes precisely due to the desire to retain their independence and preserve their privacy and intimacy. Here one can speak of “aging in place,” which the American Centers for Disease Control and Prevention define as “the ability to live

in one’s own home and community safely, independently and comfortably, regardless of age, income or ability level” (30).

One of the engineers interviewed pointed out that in developing AAL technologies, they avoided video surveillance in order to respect the individual’s privacy. This was confirmed in a study by various authors (31) who interviewed engineers involved in the development of AAL technologies on the ethics of smart homes. These engineers indicated that in their current work they paid close attention to the negative consequences of the potential unauthorized exchange of information, i.e., they focused on the protection of privacy. Therefore, the “right to privacy is a key issue that should be discussed in order to conduct gerontotechnological research and practice appropriately” (32).

In addition to the aforementioned ethical issues, it is important to highlight an ethical problem related to AAL technologies that was not raised by the participants in this study but was mentioned in a paper by Koimizu and Kokado (28), who questioned engineers in Japan about AAL technologies. The engineers cited the problem of technology addiction, associated with the “disuse” syndrome that can be defined as a physical condition caused by lying in bed, immobility and/or lack of physical activity. This is related to technology addiction. Namely, technology can be an aid and a substitute for some daily activities. If technology completely replaces some of the activities required for everyday life, “prolonged overuse of such products might deprive the elderly person of the chance or motivation to use their body more fully” (28). Moreover, some older users became attached to such products and sometimes became emotionally dependent on them, especially in the case of robots that have a social dimension. Such users appeared confused and restless when separated from their AAL technologies (28). Therefore, it is necessary to find an appropriate balance between long-term benefits and the immediate need for support in caring for the elderly with the help of technology. Elderly people usually want to conserve physical energy by using technologies, which could result in “disuse”

syndrome in the long term. It is, therefore, important to determine a level of assistance that is adequate but not excessive.

The results of our investigation lead us to emphasize the importance of a holistic, multidisciplinary approach to technology, in a manner that presupposes the mandatory consideration of users and their real needs, expectations and perceptions. Precisely because of this, and in the desire to contribute to a multidisciplinary approach to technology development and observation, this study examines the perceptions of multiple categories of participants who may be potential stakeholders in such systems. Considering the challenges and issues, whether social or ethical, it is extremely important to develop guidelines for the management of AAL technologies based on (bio)ethical principles while respecting the fundamental dignity of each human being. Such guidelines have been initiated by the AAL program funded by the European Commission. Namely, in 2020, new AAL Guidelines for Ethics, Data Privacy and Security were published (33). An updated version was published in December 2022 (34). These guidelines offer a model that integrates compliance with the general law with ethical dialogue and offer suggestions on how to establish the ethical excellence of long-lasting solutions using digital technology. These guidelines not only seek to achieve the legal and ethical regulation of AAL systems but foster ethical excellence and encourage ethical dialogue involving various stakeholders, users, legislators, researchers and manufacturers (34). These General Data Protection Regulation (GDPR) guidelines highlight some AAL principles: justice, equality of access, respect for autonomy and dignity, trust, acceptance and accessibility, transparency and choice. Ethical principles, EU regulations, international standards and national guidelines that should provide guidance for ethical dialogue are also mentioned. The ethical principles to be considered are autonomy, benevolence, harmlessness and justice. The EU regulation refers to several legal regulations, such as the protection of any undertaking involving people (i.e., the Oviedo Convention) or the

privacy and security of data dealt with by the GDPR (34). The guidelines also provide a few practical examples and allow room for analysis and dialogue (34).

It should be added that in addition to the above principles, it is very important to consider the personalistic principle of vulnerability because the effort to apply AAL represents the starting point and *raison d'être* of care for particularly vulnerable people, in this case the elderly. Accordingly, it cannot be viewed solely from a biomedical perspective (5). A holistic approach should consider ethical issues regarding the use of gerontotechnology, which includes not only problems related to the use of health technology (for example, telemedicine) but also aspects of social welfare and related issues. Moreover, it requires broader and more specific reflection on ethics, especially pertaining to in-home care.

We believe a possible weakness of this investigation is that the participants did not include lawyers or experts in the field, whose expertise could have contributed to the understanding and interpretation of the legal issues and regulations related to these technologies. Another important disadvantage was the small number of respondents per group. It should be noted that this [low] number of participants is due to the dearth of engineering experts in this field. However, with the study participants we sought to highlight views from this part of the European continent, with the hope of establishing the foundations for broader research.

## Conclusion

The results of our investigation show that the key issues regarding the social and ethical aspects of AAL are a lack of human contact, insufficient interest of the elderly in technology, the cost-effectiveness and unavailability of AAL technologies, the issue of data collection and processing resulting in threats to privacy, and the necessity for introducing legislation to ensure the safe use of such technologies. Our study showed that the engineers focused less on ethical issues. The fact is that some of them had

never considered such technologies from an ethical stance, likely due to their focus on AAL from a primarily technical perspective. As for the elderly, they expressed a need for AAL technology, as well as a dose of skepticism concerning the robotization of care, and concerns about compromising (or jeopardizing) their own intimacy and privacy. This cautious attitude does not mean that they are unreceptive toward AAL, but they desire it to be in the service of humankind, rather than pose a threat. The nurses highlighted the high rates of technological illiteracy among the elderly, which is a problem due to the resultant limitations in the use of technologies in general, as well as the inability to use advanced technology appliances. They also recognize the essential and extremely significant need of the elderly for human contact and communication, which AAL technologies cannot provide. Their fundamental view is that AAL can only be acceptable if used as an auxiliary tool to provide practical assistance for other physical tasks. This would allow nurses more time to practice their profession with greater compassion. Research on this topic often fails to consider the ethical issues regarding the use of such technologies. The complete and proper development of any technology with potential ethical concerns calls for a survey of the views of its prospective users. We believe that this study will contribute to a multidisciplinary approach to the questions raised by this issue. The ethical aspects of AAL technology include the collection, processing, use and protection of personal data. There is no doubt that AAL is needed, given the continuing rise in the elderly population and the increasingly limited number available medical personnel. Therefore, it is necessary, on the one hand, to develop this technology, which is underrepresented in Central Eastern Europe. On the other hand, deliberation on the ethical aspects of AAL technologies should be undertaken in tandem with these developments. There is an associated need to create normative guidelines for the development and use of AAL technologies, based on ethical and bioethical principles, while respecting the fundamental dignity of each human being.

## Declarations

### Authors' contributions

All the authors contributed to the study design, statistical analysis, interpretation of the data and the drafting of the manuscript. All the authors have read and approved the final version of the manuscript.

### Ethics consideration

This study obtained ethics approval from the Ethics Committee of the Catholic University of Croatia (document number 498-03-02-06/1-21-04). Before the interviews started, an informed consent document with information on the study was given to each participant.

### Funding

No funding

### Competing interests

The authors declare that they have no conflict of interest.

### Data sharing statement

Data available on request from the authors.

Code availability (software application or custom code) NA

### Supplementary files

Interview guide, informed consent (available on request from the authors).

## References

1. Loader B, Hardey M, Keeble L. Digital Welfare for the Third Age. Health and social care informatics for older people. London: Routledge; 2009.
2. Rubeis G. The disruptive power of Artificial Intelligence. Ethical aspects of gerontechnology in elderly care. *Arch Gerontol Geriatr.* 2020;91:104186.
3. Nagarajan NR, Wada M, Fang ML, Sixsmith A. Defining organizational contributions to sustaining an ageing workforce: a bibliometric review. *Eur J Ageing.* 2019;16(3):337–61.
4. United Nations Department of Economic and Social Affairs. Population Division (2022). World Population Prospects 2022: Summary of Results. 2022.
5. Eccles A, Damodaran L, Olphert W, Hardill I, Gilhooly M. Assistive Technologies: Ethical Practice, Ethical Research, and Quality of Life BT - Technologies for Active Aging. In: Sixsmith A, Gutman G, editors. Boston, MA: Springer US; 2013. p. 47–68.
6. Sixsmith A. Technology and the Challenge of Aging BT - Technologies for Active Aging. In: Sixsmith A,

- Gutman G, editors. Boston, MA: Springer US; 2013. p. 7-25.
7. European Social Network. Services for older people in Europe Facts and figures about long term care services in Europe. [Internet]. 2008.
  8. Gibson M, Gutman G, Hirst S, Fitzgerald K, Fisher R, Roush R. Expanding the Technology Safety Envelope for Older Adults to Include Disaster Resilience BT - Technologies for Active Aging. In: Sixsmith A, Gutman G, editors. Boston, MA: Springer US; 2013. p. 69-93.
  9. Singh D, Kropf J, Hanke S, Holzinger A. Ambient assisted living technologies from the perspectives of older people and professionals. In: Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics). 2017. p. 255-66.
  10. Bierhoff I, Müller S, Schoenrade-Sproll S, Delaney S, Byrne P, Dolničar V, et al. Ambient Assisted Living Systems in Real-Life Situations: Experiences from the SOPRANO Project BT - Technologies for Active Aging. In: Sixsmith A, Gutman G, editors. Boston, MA: Springer US; 2013. p. 123-53.
  11. Patel AD, H. Shah J. Ambient Assisted Living Systems: The Scope of Research and Development. *J Sci Technol Issue Inf Commun Technol*. 2017;
  12. Singbo OG. Philosophical and Theological Contributions by Romano Guardini and Jacques Ellul to the Understanding of Technological Power. *Bogosl Smotra*. 2020;90(5):1027-50.
  13. McCarthy N. Autonomous Systems: Social, Legal and Ethical Issues. The Royal Academy of Engineering. 2009.
  14. Cattan M, White M, Bond J, Learmouth A. Preventing social isolation and loneliness among older people: a systematic review of health promotion interventions. *Ageing Soc*. 2005;25(1):41-67.
  15. Nakazawa E, Yamamoto K, London AJ, Akabayashi A. Solitary death and new lifestyles during and after COVID-19: wearable devices and public health ethics. *BMC Med Ethics*. 2021;22(1):89.
  16. Vaportzis E, Clausen MG, Gow AJ. Older Adults Perceptions of Technology and Barriers to Interacting with Tablet Computers: A Focus Group Study. *Front Psychol*. 2017;8:1687.
  17. Sokullu RI, Balci A. Chapter 17 - M2M Communications and Their Role in AAL. In: Dobre C, Mavromoustakis C, Garcia N, Goleva R, Mastorakis GBTAAL and ELE, editors. Butterworth-Heinemann; 2017. p. 441-87.
  18. Anderson M, Perrin A. Pew Research Center. Tech Adoption Climbs Among Older Adults. 2017.
  19. Cicirelli G, Marani R, Petitti A, Milella A, D'Orazio T. Ambient Assisted Living: A Review of Technologies, Methodologies and Future Perspectives for Healthy Aging of Population. *Sensors (Basel)*. 2021;21(10).
  20. Pal D, Papasratorn B, Chutimaskul W, Funilkul S. Embracing the Smart home Revolution in Asia by the Elderly: An End-User Negative Perception Modeling. *IEEE Access*. 2019;7:38535-49.
  21. Bougeois E, Duchier J, Vella F, Machado M, van den Bossche A, Val T, et al. Post-test perceptions of digital tools by the elderly in an ambient environment. In: *Inclusive Smart Cities and Digital Health ICOST 2016*. 2016.
  22. Georgiev A, Schlögl S. Smart Home Technology: An Exploration of End User Perceptions. In 2018.
  23. Zhai Y, Liu Y, Yang M, Long F, Virkki J. A Survey Study of the Usefulness and Concerns about Smart Home Applications from the Human Perspective. *Open J Soc Sci*. 2014;02:119-26.
  24. Balta-Ozkan N, Davidson R, Bicket M, Whitmarsh L. Social barriers to the adoption of smart homes. *Energy Policy*. 2013;63:363-74.
  25. Hadjioannou V, Mavromoustakis CX, Mastorakis G, Dobre C, Goleva RI, Garcia NM. Chapter 11 - Cloud-Oriented Domain for AAL. In: Dobre C, Mavromoustakis C, Garcia N, Goleva R, Mastorakis GBTAAL and ELE, editors. Butterworth-Heinemann; 2017. p. 271-86.
  26. Antonucci TC, Ajrouch KJ, Manalel JA. Social Relations and Technology: Continuity, Context, and Change. *Innov Aging*. 2017 1;1(3).
  27. Stokes F, Palmer A. Artificial Intelligence and Robotics in Nursing: Ethics of Caring as a Guide to Dividing Tasks Between AI and Humans. *Nurs Philos*. 2020;21(4):e12306.
  28. Koimizu J, Kokado M, Kato K. Ethical Perspectives of Japanese Engineers on Ambient Assisted Living Technologies: Semi-structured Interview. *Asian Bioeth Rev*. 2018;10:143-55.
  29. Or CKL, Karsh BT. A systematic review of patient acceptance of consumer health information technology. *J Am Med Inform Assoc*. 2009;16(4):550-60.
  30. CDC. Healthy Places Terminology. 2009. Aging in place. Available from: <https://www.cdc.gov/healthyplaces/terminology.htm>
  31. Birchley G, Huxtable R, Murtagh M, Ter Meulen R, Flach P, Gooberman-Hill R. Smart homes, private homes? An empirical study of technology researchers' perceptions of ethical issues in developing smart home health technologies. *BMC Med Ethics*. 2017;18(1):23.
  32. Chung J, Demiris G, Thompson HJVO 34. Ethical Considerations Regarding the Use of Smart Home Technologies for Older Adults: An Integrative Review. *Annu Rev Nurs Res*. (1):155-2016.
  33. Dantas C, Hoogendoorn P, Kryspin-Exner I, Stuckelberger A, Tjink D. AAL Guidelines for Ethics, Data Privacy and Security. The Ambient Assisted Living Association; 2020. p. 22.
  34. Dantas C, Hoogendoorn P, Kryspin-Exner I, Stuckelberger A, Tjink D. AAL Guidelines for Ethics, data privacy and security. The Ambient Assisted Living Association; 2022.