



## Research article

# The experiences of daily smartphone use among older adults in Brazil: A grounded theory analysis

Adriana Martins Gallo<sup>a,1</sup>, Carlos Laranjeira<sup>b,c,d,1,\*</sup>, Juliane Pagliari Araújo<sup>e</sup>, Francielle Renata Danielli Martins Marques<sup>a</sup>, Wanessa Cristina Baccon<sup>a</sup>, Maria Aparecida Salci<sup>a</sup>, Lígia Carreira<sup>a</sup>

<sup>a</sup> Departamento de Pós-Graduação em Enfermagem, Universidade Estadual de Maringá, Avenida Colombo, 5790—Campus Universitário, Maringá 87020-900, Brazil

<sup>b</sup> School of Health Sciences, Polytechnic University of Leiria, Campus 2, Morro do Lena, Alto Do Vieiro, Apartado 4137, 2411-901, Leiria, Portugal

<sup>c</sup> Centre for Innovative Care and Health Technology (ciTechCare), Polytechnic University of Leiria, Campus 5, Rua Das Olhalvas, 2414-016 Leiria, Portugal

<sup>d</sup> Comprehensive Health Research Centre (CHRC), University of Évora, 7000- 801 Évora, Portugal

<sup>e</sup> Departamento de Pós-Graduação em Enfermagem, Universidade Estadual de Londrina, Rodovia Celso Garcia Cid, PR-445, Km 380 - Campus Universitário, Londrina 86057-970, Brazil

## ARTICLE INFO

## Keywords:

Smartphone  
Internet  
Healthy aging  
Communications media  
Older people  
Qualitative study  
Brazil

## ABSTRACT

**Background:** Digital inclusion of older people is an important agenda for the future and well-being of the older population, as it represents a form of social inclusion with significant gains for healthy aging. The present study aimed to understand the experiences of Brazilian older adults who use smartphones and the implications in their daily lives.

**Method:** A qualitative study was developed using a constructivist grounded approach. Older people ( $\geq 60$  years) with prior access to a smartphone were invited to participate in the study. Participation took place through semi-structured, audio-recorded interviews. Data collection and analysis occurred simultaneously using a constant comparative approach. Data management and analysis used the Atlas.ti® software.

**Results:** Overall, 37 older people participated, with an average age of  $70.60 \pm 6.95$  years, predominantly female ( $n = 33$ ), white ( $n = 25$ ), married ( $n = 26$ ) and retired ( $n = 27$ ). The first sample group included 27 older people with family support and the second group included 10 older people without family support (who lived alone in their homes). A core category emerged from the data analysis—“Expanding the personal and social development of older adults through smartphone communication”—around which three main categories emerged: 1) The smartphone as “a window to the world”; 2) The problem of misinformation and fake news on virtual networks; 3) Technological paradoxes in the use of smartphones.

**Conclusions:** The digital transition associated with smartphone use brings unimaginable benefits to older adults who adopt positive habits to improve their well-being and expand their social connections, following efforts proposed by the Decade of Healthy Aging. However, older adults

\* Corresponding author. School of Health Sciences, Polytechnic University of Leiria, Campus 2, Morro do Lena, Alto do Vieiro, Apartado 4137, 2411-901 Leiria, Portugal.

E-mail addresses: [adriana.gallo@ifpr.edu.br](mailto:adriana.gallo@ifpr.edu.br) (A.M. Gallo), [carlos.laranjeira@ipleiria.pt](mailto:carlos.laranjeira@ipleiria.pt) (C. Laranjeira), [juliane.pagliari@ifpr.edu.br](mailto:juliane.pagliari@ifpr.edu.br) (J.P. Araújo), [franrenata.martins@gmail.com](mailto:franrenata.martins@gmail.com) (F.R.D.M. Marques), [wanessabaccon@hotmail.com](mailto:wanessabaccon@hotmail.com) (W.C. Baccon), [masalci@uem.br](mailto:masalci@uem.br) (M.A. Salci), [ligiacarreira.uem@gmail.com](mailto:ligiacarreira.uem@gmail.com) (L. Carreira).

<sup>1</sup> These authors contributed equally to this work and shared the first authorship.

<https://doi.org/10.1016/j.heliyon.2024.e35120>

Received 15 April 2024; Received in revised form 21 July 2024; Accepted 23 July 2024

Available online 26 July 2024

2405-8440/© 2024 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

still face disparities and experience a significant digital divide, which represents a major challenge. Barriers to access are further aggravated in developing countries. We hope this study contributes to public health policies on digital inclusion and healthy aging.

## 1. Introduction

Globally, population aging is occurring at an accelerated pace [1]. In Brazil, this growth is evidenced in projections that indicate that, after 2030, the older population (60 years or more) will be larger than children below 14 years of age. In 2055, the portion of older adults in the total population will be greater than that of children and young people [2]. Healthy life expectancy and the use of information and communication technology, such as smartphones and mobile messaging applications for older adults, have increased at an unprecedented pace [3–5]. Concomitantly, people are constantly challenged to stay updated and digitally engaged, thus avoiding the feeling of exclusion [1]. The COVID-19 pandemic's containment measures left consequences, especially social distancing, which changed the patterns of connection between people and highlighted new potentials regarding older adults' use of technological resources [6]. In Brazil, the percentage of older adults ( $\geq 60$  years old) with access to the internet increased from 24.7 % in 2016 to 62.1 % in 2022 and, according to IBGE [2], cellular mobile devices were the main means to access the internet (98.9 %).

The information revolution occurred quickly, transforming people's lives and enabling access to information and instant communication [7]. With digitalization, the problem has moved from scarcity to excess information, sometimes aggravated by the inappropriate use of the content available online [1]. The infodemic represents a global problem, especially for older adults, who, due to their vulnerability, tend to be subject to the consumption and replication of fake news [8].

There is a duality in an aging society that encourages experts to seek answers to improve well-being in aging. On the one hand, the perspective of healthy aging is focused on eliminating inequalities and changing how we think and act regarding old age [1,7,9]. On the other hand, in the analog-digital transition, the lack of digital literacy among older adults is accentuated by social inequality in access to and use of digital resources [10]. This issue may become less of a problem as the population ages, as the newer generations of seniors will already have been exposed to digital technologies before they grow older.

The smartphone is an additional resource that favors this population's participation in internet-based activities and remote conversations as a means of social participation and strategy to preserve cognitive reserve [11]. There are increasingly more mobile applications to promote older adults' health and care [12]. Healthcare technology promotes healthy aging [12,13], as it allows learning or researching health information with a positive impact on how healthy older people assess themselves [5]. Crucially, these tasks enable older people to age in place (promoting their independence and autonomy) and enhance their life satisfaction, particularly when they experience substantial declines in physical and mental abilities.

Based on a socio-ecological perspective of healthy aging, older adults must be allowed and encouraged to participate socially, using strategies to enhance their independence [12,14,15]. The functional and cognitive decline associated with old age can be minimized through preventive interventions [11] and intelligent assistive technologies [8,12,14]. Recently, digital innovations have been considered as support tools with the potential to overcome the fear of being unable to self-care, thereby increasing satisfaction with the ability to control one's life [5,12,15]. Some skills are essential for lifelong learning, fostering personal fulfillment, a healthy and sustainable lifestyle, employability, active citizenship, and social inclusion [16]. Digital competence is one such skill, whereby digital technologies are used for social participation, work, or learning, in a confident, responsible, and critical way [16]. In this regard, older people must be ensured access and skills to use digital technologies, contributing to changes that impact their lives [16–18].

The constant technological advancement is not enough to digitally educate older people. The expansion of digital skills and abilities through flexible strategies for this audience—considering their user experience, perception, and acceptance of information and communication technology (ICT)—contributes to minimizing the impact of social segregation. Programs that foster or reinforce social support to promote digital skills in older people are important and urgent [18].

The Senior Technology Acceptance Model (STAM) proposed by Chen and Chan [19], and later simplified by Chen and Lou [20], identifies a wide range of factors associated with the adoption of technologies by older adults. The authors suggest that interactions with technology are affected by the characteristics of older adults, including physical aspects (functional and cognitive capacity), psychological aspects (anxiety or self-efficacy associated with gerontechnology), social relationships, and attitudes toward aging [20]. At the same time, predictive determinants of technology use—such as performance expectation, effort expectation, social influence, and facilitating conditions [21]—are moderated by variables such as gender, age, voluntariness, and previous experience. A recent systematic review suggests that researchers need to acknowledge the complex relationships among various factors and attribute the specific roles of technology user, actor, and co-creator to older adults [22]. Moreover, to promote aging in place, several digital health technologies have been developed, enabling older people with chronic conditions to adhere to therapeutic regimens, facilitate communication with healthcare professionals, and enable timely intervention, thereby reducing hospitalization and avoiding institutionalization [23].

Although this field of study is already consolidated in developed countries [20,24], it still represents a major challenge in Latin American countries [25,26], particularly Brazil, that need to develop innovative and inclusive approaches to promote health and social relationships of older adults through their digital inclusion in an intergenerational perspective [3,14,15]. Post-pandemic studies show that older adults already accustomed to using smartphones before the health emergency had better mental health rates compared to those who did not have previous access [8], with long-term impacts on the aging process [8,9]. Moreover, there are few qualitative studies with a holistic perspective, such as in-depth analysis, that focus on technology adoption [27].

Given this scenario, the following research question arises: How do Brazilian older adults incorporate the use of smartphone technology into their daily lives as a strategy to promote healthy aging? This study aimed to understand the experiences of Brazilian older adults who use smartphones and their implications for daily life. Consequently, this study hopes to expand knowledge about the use of technological resources in the aging process, according to the guidelines of the Decade of Healthy Aging (DES) 2021–2030 [9], specifically regarding community promotion of older people’s capabilities and implementation of integrated health services centered on the person and their circumstances.

## 2. Materials and methods

### 2.1. Study design

A qualitative inquiry approach was carried out based on the methodological framework of Constructivist Grounded Theory (CGT) [28], which consists of an inductive-deductive method where the construction of theory requires interaction between researchers and participants, thus producing an interpretative picture of reality. Charmaz’s grounded theory approach believes that multiple perspectives of reality are developed by comprehending participants’ experiences [28]. Therefore, it ensures a participant-centered understanding, providing a voice to the community. Charmaz [28] also posits that knowledge is always evolving and shaped by both the researcher and participant, rather than being fixed or waiting to be uncovered. The grounded theory flow chart is depicted in Fig. 1.

The Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist [29] was used to develop and report this study.

### 2.2. Setting, participants and recruitment

The study scenario was a Municipal Senior Living Center located in the northwest region of the state of Paraná (Brazil) that serves an average of 500 people per month and develops community outreach activities that promote the use of smartphones as a resource for providing health and well-being guidelines that promote healthy aging [30].

Potential participants were purposefully selected from a community extension project “Vovôs e Vovós Conectados” [30]. This project serves older people in the community who attend a municipal senior living center, which offers different occupational and social activities guided by health and education professionals. Subsequently, the project coordinator provided information about the study to individuals who met the inclusion criteria: a) older adults 60 years old or over [9]; b) smartphone users with internet access; c) participated for at least 6 months in the community extension project “Vovôs e Vovós Conectados”; d) and no cognitive impairment. To assess the latter criteria, the Mini-Mental State Examination (MMSE) was used. Older adults with scores equal to or greater than 27 points were included [31]. We excluded people who had cognitive impairment because they present more difficult experiences with smartphones use and their condition would prevent them from completing the interview.

Participants were recruited regardless of sex, race, or family support, allowing for maximum sample variation. As a result, 37 people participated in the study and were organized into two sample groups. The first sample group included 27 older people with family support and the second group included 10 older people without family support, who lived alone in their homes. The evidence suggests that family support improves older people’s physical and mental health-related quality of life [32] and life satisfaction [33]. In this vein, significant and positive relationships between social support and smartphone usage found previously in the literature [34] provided the rationale for creating both sample groups. Sample sizes were determined during the phase of conceptual investigation, when no further empirical data was generated, thereby signifying the attainment of theoretical saturation [28]. Sample size guidelines recommend a range of 20–30 participants to reach saturation in a grounded study should [35,36]. While our sample comprised 37 people in total, by the 28th interview the core category had already been identified and dimensionalised.

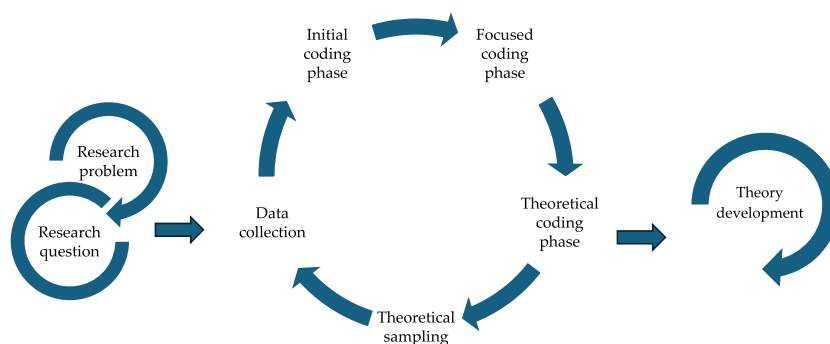


Fig. 1. – Qualitative study design.

### 2.3. Data collection

Data collection took place from August to October 2022. The research invitation occurred by telephone and the interview was scheduled. The informed consent form was sent via WhatsApp®. Subsequently, participants returned the signed form by mail. To track cognitive impairment in older adults, individual online sessions were held using Google Meet®. Before the interview took place, the participants responded to an online form to provide personal information. This helped establish an initial rapport.

The individual interviews were guided by a script prepared by the researchers based on the literature [8,19–21,37] and focused on the following areas: the experience of older adults using the internet via smartphone; its perceived usefulness; facilitators and constraints in smartphone use; and implications of technologies on the health and well-being of older adults. The entire script was validated by three experts and analyzed for content, form, and question comprehensibility; after which minor adjustments were made.

The interviews were carried out by telephone, using a conventional phone line or WhatsApp®. The interviews lasted an average of 30 min (ranging from 20 to 80 min). Data collection was carried out by a registered nurse with around 13 years of clinical experience with older adults, professionally trained in qualitative research, and a PhD candidate in Nursing, when data was collected. To mitigate social desirability bias and response bias, a nonconfrontational and respectful approach was adopted during interviews, using some questioning techniques (e.g., open-ended questions; requesting stories and examples; reformulating, summarizing, and remaining silent during interviews to encourage the interviewees to express their inner feelings) and rapport building (e.g., active listening; conveying empathy; using humor; and establishing trust).

All statements were audio recorded, transcribed into a text document, and checked using Reshape®. The interviews were categorized by order of completion (P1–P37), type of family support (alone or accompanied), and age.

### 2.4. Analysis

The data were collected and analyzed sequentially in three coding phases: initial, focused, and theoretical. In the first phase, incidents were initially coded to understand the information based on the participants' meanings and experiences, thereby forming the first dimensions of the analysis. Then, in the focused coding phase, the most expressive codes were grouped to create abstract categories synthesizing a certain aspect of the data [28]. Finally, data analysis highlighted participants' main concerns and incorporated theoretical concepts corresponding to the data. As certain concepts emerged with greater frequency and relevance, subcategories and categories were created, revealing the central phenomenon of the research [28]. The first author conducted the analysis and regularly consulted with the co-authors. Preconceived views regarding the study data were minimized by reviewing the literature related to the topic after analyzing the data. The analytical process was thereby audited, tracking the theorizing process. The coding and analysis process was carried out using the ATLAS.ti® software. The entire analysis was conducted in Portuguese. The final results were translated into English.

### 2.5. Study rigor

The study's rigor was guaranteed by criteria proposed by Charmaz [28], namely: credibility, originality, resonance, and usefulness. Credibility was ensured by meticulous care with the data during interview transcription; when taking notes and constructing memos (constantly compared); and by prolonged engagement to gain a deep understanding of the phenomenon being studied. The time the researcher was involved with the interviews and the bond with each participant promoted a harmonious and confident relationship and a welcoming and relaxed environment, which fostered the sharing of experiences. Another strategy to increase credibility was reaching data saturation, when selected participants ceased providing new information [38].

Originality was evidenced using memos and schematic representations of the phenomenon associated with the researcher's reflective process, which facilitated discussion between peers [39]. Resonance indicates that researchers created concepts that accurately reflect participants' experiences but are also capable of being applied in different contexts. To this end, a combination of deductive and inductive analysis was used, fostered by the CGT method, making sense of the findings within the framework of previous research and therefore suggesting their transferability. To minimize researcher bias, reflexivity in the research process was essential because it enabled scrutinizing the co-construction of knowledge. Thus, the team of researchers included nurses with experience in geriatrics (A.G., W.B., F.R.D.M.M.) and qualitative research (C.L., L.C., MAS, J.P.A.), particularly in the constructivist epistemological perspective of CGT [28]. During data analysis, the emerging understanding and interpretation of the data were presented to the team, followed by critical discussion and questioning.

Finally, usefulness encompasses the ability to deepen research participants' comprehension of their daily experiences, the establishment of a foundation for the development of policies and good practices, the progress in emerging research areas, and the discovery of processes and practices that can be applied in similar contexts.

### 2.6. Ethical considerations

The research was approved by the Research Ethics Committee under opinion no. 5,553,406 and CAAE: 57993522.0.0000.0104, according to the ethical precepts relating to research with human beings, under Resolution 466/12, and the national and international standards of ethics in research involving human beings. The study procedures respected the rights and dignity of the participants and written informed consent was obtained. Participation was voluntary, and participants could withdraw from the study at any time. No monetary compensation was offered for participation.

### 3. Results

#### 3.1. Participants' characteristics

The sample included 37 older smartphone users, mostly female ( $n = 33$ ), white ( $n = 25$ ), retired ( $n = 27$ ), married ( $n = 26$ ), and with an average age of  $70.60 \pm 6.95$  years (range from 60 to 86). Despite being retired, given their limited income, some participants required a paid professional activity to live ( $n = 10$ ). Most participants mentioned a daily smartphone usage time of 1–2 h ( $n = 17$ ). Participants reported previous comorbidities, especially hypertension ( $n = 17$ ). Most perform physical activity ( $n = 25$ ). Table 1 presents the characteristics of each sample group.

#### 3.2. Findings from interviews

Data analysis generated a core category—“expanding the personal and social development of older people through smartphone communication”—, around which three main categories emerged: 1- the smartphone as “a window to the world”; 2- the problem of misinformation and fake news on virtual networks; 3- technological paradoxes in smartphone use. Fig. 2 provides an overview of the categories and subcategories.

In CGT, the core category relies on the researcher's intuitive and interpretive analysis of the data (i.e., it is researcher-driven). In this study, our core category captures the experiences of older people when they use smartphones as well as the value of technology in their daily life. The increasingly accelerated pace of discoveries related to the use of ICTs and their practical applications promotes flexibility in some daily activities, introduces new virtual modes of communication, and approaches and maintains the social contact of older adults through social networks. Democratic access to resources that promote the digital inclusion of older adults guarantees that ICTs and the Internet are not restricted to a minority of older adults, nor do they represent yet another mechanism for reproducing social inequalities.

##### 3.2.1. The smartphone as “a window to the world”

The participants' narratives point to a profile of older adults increasingly involved in digital activities, using smartphones as an access tool. Daily smartphone use is an important mediator for carrying out instrumental activities of daily living [IADL] (e.g., shopping, scheduling appointments, managing bill payments), which favors the independence of older adults.

**Table 1**

Description of study participants ( $n = 37$ ).

Variables	Older adults with family support ( $n = 27$ )	Older adults without family support ( $n = 10$ )
<b>Age (years)</b>		
Mean $\pm$ SD (range)	72.0 $\pm$ 6.84 (60–86)	66.8 $\pm$ 6.01 (60–79)
<b>Sex, n (%)</b>		
Male	4 (14.8)	0
Female	23 (85.2)	10 (100)
<b>Race, n (%)</b>		
White	19 (70.4)	6 (60)
Black/African descent	8 (29.6)	4 (40)
<b>Marital status, n (%)</b>		
Married	26 (96.3)	0
Widow	0	7 (70)
Separated	0	2 (20)
Single	1 (3.7)	1 (10)
<b>Occupation, n (%)</b>		
Paid professional activity	9 (33.3)	1 (10)
Retired	18 (66.7)	9 (90)
<b>Daily Smartphone usage time, n (%)</b>		
$\leq 1$ h	5 (18.6)	1 (10)
1–2 h	12 (44.4)	5 (50)
2–3 h	7 (25.9)	2 (20)
$\geq 4$ h	3 (11.1)	2 (20)
<b>Self-Reported Health Comorbidities, n (%)</b>		
Hypertension	13 (48.1)	4 (40)
Diabetes	6 (22.2)	1 (10)
Anxiety	6 (22.2)	2 (20)
Depression	2 (7.4)	2 (20)
Overweight	2 (7.4)	1 (10)
Vascular	1 (3.7)	0
<b>Weekly Physical Activity, n (%)</b>		
Yes	18 (66.7)	7 (70)
No	9 (33.3)	3 (30)



**Fig. 2.** Overview theory: Experiences of older Brazilians using smartphones in daily life.

[...] I use Whatsapp®, Facebook®, Messenger®, [...] as a telephone, because I don't even have a landline (phone line) anymore ... oh, for the bank too. I have PIX (Brazilian instant payment) at the bank account. (P7; Alone, 72 years old)

[...] to resolve legal matters, we send documents, photos of documents ... Also to make an appointment, we send a photo of the card. So, for example, when the appointment is in Maringá (municipality), the internet helps me a lot. (P23; Accompanied, 72 years old)

I look for a lot of new things on my smartphone, music sheets, because I take guitar lessons at the senior center. I look for cooking recipes, crafts and it makes me happier, it's a way to spend my time. As I don't like watching normal television, I go straight to YouTube, I like the internet much more (P29; Alone, 69 years old).

At the same time, technological resources allow older adults to dispel preconceptions associated with old age (e.g., ageism, unproductivity), and thus facilitate the development of leisure activities that increase levels of well-being.

And then it ends up bringing people together, using time to connect with other people. This brings happiness and well-being. And, in the long term, it helps us age healthily. [...] I also learned and cooked dishes from other countries. (P31; Accompanied, 66 years old)

[...] I'm reading a book. I'm loving it. (P1; Accompanied, 70 years old)

[...] I use it more to see WhatsApp® and some information on Facebook. I also look up the senior center, which always offers interesting activities to activate memory, providing more information about health through physical exercises. (P27; Accompanied, 68 years old)

Whether a person can age healthily or not because of technology depends on each person. People who do not have access to the internet are wasting away and losing access to knowledge, they are losing opportunities (P30; Accompanied, 70 years old).

The ease and fluidity with which information is transmitted over a network is new to most older adults (who until then needed different analog resources, not always accessible for communication). The use of smartphones also promoted spiritual self-care and strengthened ties with geographically distant family and friends.

[...] I use it first for communicating with my children. Then for religious communication, I do my prayers through my cell phone. I receive prayers. And I also call my friends. I only have about 150 in my diary, a circle of great friendship. (P8; Accompanied, 86 years old)

[...] (using a smartphone) has changed a lot because I live far from relatives and we can't always be together, talking. Using cell phones and the internet has helped our lives a lot, to communicate. (P24; Alone, 74 years old)

[...] You can talk to people from far away. Me, for example, my sister is in Spain. (P7; Alone, 72 years old)

I have a sister in Switzerland, on the other side of the world, I talk to her, and also with my sister in the state of Mato Grosso [Brazil]. I communicate in the moment and it's very quick, it's great to talk to both of them together, you know? (P17; Accompanied, 72 years old)

At the same time, P20 added that the smartphone as a "window to the world" allowed him to meet a family member he would otherwise have been unable to contact, and thus managed to preserve family cohesion.

[...] I didn't know part of the family on my father's side. It was thanks to the internet that I started talking to a half-sister, who lives in the United States. We have never seen each other; we have our father in common and we talk to each other as if we had been sisters our whole lives. How could I have gotten this type of information and relationship if we didn't have the smartphone to call? (P20; Alone, 60 years old)

Also noteworthy is the report by some participants whose immediate access to information in the media kept them permanently updated without leaving home. Being connected to your cell phone means being involved in the digital universe and receiving instant information, thereby reducing distances and allowing one to feel part of the digital advancement, rather than feel left behind.

[...] (using a smartphone) is a way for you to get things that are sometimes on the other side of the world and you open a website, something and you have this information (P31; Accompanied, 66 years old)

[...] this way I don't need to leave home to seek knowledge and practice it (P33; Accompanied, 76 years old)

[...] (smartphone) is all we have to communicate, to be part of everything that happens in the world (P15; Accompanied, 68 years old)

[...] Lately, I've been watching some political videos, because I don't understand anything about politics. So, now with this revolution we are in, it is good for us to understand the sides. It's good to know what we're experiencing and having everything on your cell phone. (P28; Alone, 67 years old)

### 3.2.2. The problem of misinformation and fake news on virtual networks

Participants recognize the problem of misinformation in virtual environments and are aware of the importance of understanding and recognizing fake news. Likewise, they understand that sharing false information contributes to misinformation and thus harms society in general. However, they cannot envisage safe ways of confirming the information's veracity, reiterating that they still need to learn about the subject.

I wait for the truth because there is a lot of fake news and you don't know how you're going to find out if it's true or if it's a lie. It creates an expectation that makes you a little suspicious. (P3; Accompanied, 60 years old)

I don't know much about that (fake news). I still don't know how I can prove whether it's true or not. (P1; Accompanied, 70 years old)

As we understand a little about cell phones, when questionable news arrives, I delete it. I don't pass on that information and I report the phone contact. This is a way of protecting myself from the scam. (P8; Accompanied, 86 years old)

There are a lot of things on the internet that come via smartphone that we know are not true, for example there are many medicines that pass off as miracles which are often false (P12; Accompanied, 86 years old)

Although they recognize the problem of fake news and are concerned about the issue, some participants report that false information appears so truthful that they fear they've already suffered cybercrimes (e.g., phishing), or have in fact been victimized, even though they consider themselves to be informed people.

This week, unfortunately, despite everything I know, everything I've been warned about, I fell for a money transfer scam. Can you believe it? The lie was so true. (P22; Accompanied, 63 years old)

I even know things, but in a moment of inattention, I fall for a scam. (P25; Alone, 75 years old)

The cell phone came to help, but banditry takes advantage of everything. When they launched PIX (Brazilian instant payment), which can be done via cell phone, who would have thought that a simple PIX would accumulate so much banditry as we are seeing today. (P8; Accompanied, 86 years old)

Older adults say it is difficult to know whether something is true or not without solid evidence, which is often not available. With so much misleading information circulating online, having doubts and concerns is natural. The best way to deal with this is to research and compare different sources of information to get a more accurate and complete picture.

Older adults have to be even more cautious because the worst thing is to spread it, right? (P28; Alone, 67 years old)

[...] because one moment you see the same things one way, and then you see them another way, so ... which one is right? (P5; Accompanied, 84 years old)

[...] I'm worried about whether they're true because there's some information that we see that is very critical [...] There is a weight loss business, they say it works [...] This is just to encourage people to spend (money), so I don't trust it, no. (P27; Accompanied, 68 years old)

[...] I like to look at several places first to get an idea. Thus I look for certainty (P24; Living alone, 74 years old)

### 3.2.3. *Technological paradoxes in smartphone use*

Participants face contradictory qualities in using smartphones that can affect the consumer experience and overall user behavior. Paradoxes generate feelings that ultimately determine the propensity or resistance to using smartphones.

The first paradox results from the ambivalence between competence (knowing how to use the device) and incompetence associated with the complexity and difficulties in use. Older adults recognize some limitations are real: some are physical, such as vision or sensory difficulties (touch screen), and others are cognitive. This generates a fear of doing something wrong and disfiguring or breaking the equipment, thereby compromising its use.

[...] To be honest with you, I'm scared. Fear of sending a message in the wrong place, fear of breaking one thing or another, it's complicated (laughs). (P25; Accompanied, 75 years old)

[...] We are very limited, the elderly. The young, you see ... a child takes the cell phone and touches everything. We have more difficulty pressing it on the screen because we started very late. (P1; Accompanied, 70 years old)

[...] You know that sometimes I prefer to go to the computer and do this, due to the difficulty of things being small. We don't see it and there we enlarge it. I think (the computer is) more practical and I end up going to the computer. (P21; Accompanied, 66 years old)

The second paradox refers to the ambiguity between the desire for control and disorder, particularly when expectations are not met, which can cause anxiety and disappointment. Participants feel pressured to respond promptly to phone calls, messages, and other smartphone stimuli for fear of appearing arrogant or unapproachable.

We see people carrying their cell phones back and forth as if they need it all the time. So, I believe that if there is no policing (surveillance), this urgency will do more harm than good. (P28; Alone, 67 years old)

In the early hours of the morning, I never check my cell phone. But the next day, when I went to check it, people had sent me messages at two or three o'clock in the morning. I keep thinking, were they awake until these early hours of the morning? Can't you lose sleep over this, thinking the other person will be awake and respond soon? No, only in the morning, the next day, do I respond with a good day! (P2; Alone, 67 years old)

You have to know the right time to stop, what time to eat, for example, knowing when it's time to put your cell phone aside, right? Even if you have to respond to messages, leave it for later (P22; Accompanied, 63 years old)

On the other hand, the speed of communication can generate a desire for immediacy in problem-solving and communication. Older adults recognize this and consider it can be harmful, even as a warning sign.

[...] Everything is fast on the internet, for example, if I send a message to my son and he has already seen it, I think he already has to respond. Thinking like this, I think this is not healthy! Because then the elderly become more anxious. Because I've talked to a lot of people and I know some friends like that. I always say, just because the person saw it doesn't mean they have to respond, you don't know what's happening in their world, right? You have to know the real and the virtual world. (P28; Alone, 67 years old)

The third paradox refers to the ambivalence between freedom and dependence. The freedom gained by the possibility of being connected, regardless of place and time, creates a new form of dependence. Older adults feel a need to be permanently connected to the internet, showing more signs of emotional dependence on the device and less ability to control smartphone use.

I have an aunt who is over 80, who also lives alone, she is addicted to her cell phone, she goes on this social networking site and this is also very dangerous for the elderly, you know? (P28; Alone, 67 years old)

We say that children (grandchildren) spend a lot of time on their cell phones, which is not healthy, but what can we say? My husband also uses his cell phone all the time when he's at home. So there are things I think about ... it's good and it's not (P1; Accompanied, 70 years old)

The fourth paradox is between the old and new needs. Technology can supply and satisfy desires and needs, but it can also create new, previously unconsidered uses. The smartphone is a care tool, as it allows older adults to have useful occupations. Although there are individual limitations, this does not prevent them from maintaining a flow of synchronous or asynchronous communication with others. With aging populations, older children care for older parents, generating a feeling of empathetic understanding that brings them closer to satisfying their needs for affection, sharing, and support.



[...] My mother is 92 years old, so she has reached a point where nothing is relevant anymore. [...] she can't walk, but you have to think that she has a good head and that's why the cell phone helps her to stay useful and busy (P22; Accompanied, 63 years old)

My mother is 85 years old, and I installed WhatsApp® for her. She turned out so well, you know? Because she likes to know about one thing or another, every day she says good morning, good night. If it takes a little while for us to send you some news, she asks how you are, what you are doing, I want to know from you. (P28; Alone, 67 years old)

[...] My mother, she was 75 years old, and she could handle the cell phone [...] And we taught her once, something or other and she would come and ask us again, but she was happy with that cell phone in her hand, talking to friends. If I needed to, I would like them to do the same for me. (P31; Accompanied, 66 years old)

The fifth paradox refers to the tension between efficiency (the possibility of carrying out tasks more quickly and with less effort) and inefficiency (with tasks that may require more time and effort). There is a clear concern about using the smartphone with versatility. Although there is curiosity in knowing the wide spectrum of possibilities when using a smartphone, there is no great expectation about exploring them in detail, either due to lack of interest or lack of knowledge. Most interviewees only use the device's basic functions, thereby removing the stigma of incompetence, ignorance, and digital exclusion.

[...] I prefer not to explore or see, depending on the subject. I prefer to be more aloof, but only when I don't understand or don't know how it works. (P18; Accompanied, 74 years old)

[...] What is more complex, I don't even go too deep. I already ask my daughter to resolve the matter. But as far as I got, for me, it was, like, very calm. (P22; Accompanied, 63 years old)

[...] everyone's work depends on this technology [...] For me, I don't need to learn much, just using my cell phone is fine. I don't need to use the computer, nothing, because I'm already retired. I won't depend on that for work. (P2; Alone, 67 years old)

Some things we don't understand a little, but on my life, I think that what I know is already good. But of course, it's good to always learn. I tell anyone who wants [...]. Better to learn, but what I know is already good for me. (P25; Accompanied, 75 years old)

Finally, the sixth paradox refers to the fact that technology can facilitate personal development but can also pose a limitation due to scarce digital literacy. Given that older adults are not part of the generation of "digital natives", they refer to the superficial attention they receive from younger people who use smartphones. In this sense, older adults who do not engage with smartphones become more vulnerable and uninformed, demonstrating a lack of personal evolution. On the other hand, when they can use their cell phone independently, it gives them feelings of security and well-being.

[...] As I am alone, it is a form of distraction for me and also of learning, and I like to learn things. (P29; Alone, 69 years old)

[...] You know that I didn't learn this part (using the smartphone) on my own. And my children don't have much time to come here. And even if they did, I know they wouldn't want to teach me. (P7; Alone, 72 years old)

[...] For me, there has been a lot of change, because, for example, as I live alone, my daughter doesn't come to my house every day, because they work, right? They communicate with me every day. Even if we don't talk, we exchange a good day and a good night. (P29; Alone, 69 years old)

[...] So, for me it gives me security and at the same time even encouragement because you don't feel alone because there is a group that helps you reason. It indirectly gives support to those who seek it, right? (P34; Accompanied, 65 years old)

#### 4. Discussion

This qualitative study is one of the first attempts to understand the experiences of Brazilian older adults using smartphones and the implications in their daily lives. Our findings reflect the narratives of older adults aged between 60 and 86, with different perceptions regarding smartphone use and accessibility to digital social networks. According to our findings, the smartphone permeates older people's specific needs for communication equipment, awakening interest in its use to make life easier in different domains, such as the development of new relationships by allowing personal growth and learning and by providing a platform for new hobbies [3].

The STAM model [19,20] revealed that perceived ease of use is a crucial factor in determining technology adoption. For older adults, their self-determined search for well-being and quality of life is central [40]. Therefore, the usability of digital equipment is dependent on prior digital literacy, pleasantness, usefulness, and ease of use, in addition to safety and efficiency [41]. Aging and digitalization are two major trends in modern society, given the rapid increase in smartphone users and its uses among middle-aged and older adults [42]. The expansion of personal and social development through smartphones is experienced as beneficial by aging people [4,43] and emerges as the core category of our study. This is aligned with the WHO's principles for the decade of healthy aging [8], which aim to break stereotypes that discourage society from taking proactive attitudes regarding the use of technology [9].

Our findings support previous studies indicating that smartphone use by older adults improves their life satisfaction and independence [12,15] and reduces depression symptoms in this population [44]. At the same time, greater IADL abilities generate feelings of belonging and independence [4]. Research largely supports the favorable impact of smartphone technology on older adults [45,46].

One study revealed that older adults can use smartphones for various objectives, such as making electronic payments, accessing online banking services, online shopping, and e-commerce activities [45], and maintaining their well-being via the use of managed care apps [47]. Most older people seek immediate access to information and organize their instrumental and leisure activities through digital devices, which mitigates the negative stereotypes associated with aging [13]. Once proficient in using smartphones in their daily activities, older adults perceive themselves as similar to young and middle-aged individuals in terms of technological skills [4]. In addition, the use of technological resources in daily life indicates that older adults are active participants in modern society [41]. Older individuals may need more social activities to sustain social connections and decrease feelings of despair and loneliness, while enhancing pleasure and contentment [48,49]. Currently, older adults can use smartphone applications to embrace the cyber-culture and improve their overall quality of life [50], feeling younger than their actual age [51].

In line with the current literature, our findings indicate that smartphone use strengthens and improves social connections and contributes to spiritual growth [12]. Enhancing digital accessibility to religious practices can help individuals overcome daily challenges like work and family commitments, time constraints, transportation issues, and the financial burden of attending physical religious services. This enables people to balance their religious/spiritual practices with the demands of their lives [52]. At the same time, promoting exercises related to cognitive stimulation and healthy habits (such as implementing routine physical activities, proposed by videos in apps) proved to be attractive for older adults, improving their physical and mental state [40], in addition to encouraging the maintenance of significant interpersonal relationships [53,54]. Also, by promoting reminiscence, using a smartphone application can reinforce the bridge between the past and present, allowing older adults to relive positive experiences [4,53,55].

People interact through conversations, one component of their social communication, associating linguistic ability and cognitive health [11]. The change in communication patterns may not have translated into a sustained use of new technologies by older adults, but there was an increase in activities or social connections, expanding their virtual social networks. This is also supported by studies demonstrating the use of smartphones as information and communication technology by older adults, impacting improvements in health-related outcomes throughout life [4,40,43,53].

The transition from analog to digital resources entails far more than changes in physical equipment, involving a transformation in how we share life [8]. Sensibility is necessary when applying principles of analog-digital transition to older people who need training and mastery of new resources since material and mental ability is a prerequisite [40]. Regarding communication, many older adults have, over time, given up their landline home telephone [56] and adopted the use of smart and networked phones [4,5]. Promoting digital literacy contributes to protecting personal information and ensuring security in the virtual world [49]. Participants in our study indicated that they are attentive to the veracity of the news [43], reiterating that it is necessary to know how to deal with the fake news that proliferated during the pandemic [10]. Virtual communication has become an important source of (mis)information, popularly known as fake news, which was disseminated *en masse* during the pandemic, contributing to exacerbated stress and anxiety [57,58].

Our findings also show that messaging applications, when used in specific groups for older adults, are extremely useful tools in promoting knowledge and creating rapport between unknown members, as well as facilitating personal and social development (including sustainable virtual relationships), by bringing people together and improving each other [59]. The affordable cost associated with smartphone use makes it an accessible communication tool with family and friends, bringing geographically distant people closer together [3,56]. A recent meta-analysis emphasized that social effects, such as discussions with family, friends, and professional caregivers, significantly influenced the desire to use digital technology, particularly during the initial phases of adoption [60].

Older people live with a set of technological paradoxes that establish a dialectic of advantages and disadvantages regarding smartphone use. Older people experience the rapid transition in the digitalization of equipment, devices, services, and products by feeling unable to take advantage of their full benefits, thus contributing to weaker social connections and worse physical or mental health outcomes [43]. Stereotypes internalized throughout life generate prejudices associated with old age that interfere with health and well-being [4]. Although there is progress in older citizens' acceptance of technologies [13,61], our findings further reinforce the self-perception of limitations concerning technological proficiency, notably the lack of digital skills [9,15,62]. Older people only mobilize essential skills when using a smartphone, corroborating the frequent self-perception that they are "too old" to learn new things [4].

Our study revealed that older people who were most active in using smartphones maintained a desire to remain independent and avoid feeling like a burden on family, friends, or society [14]. Younger generations, who have experienced the advantages of using smartphones, may recommend that older people use them primarily to maintain communication with their family and friends. Studies have shown that older individuals are receptive to embracing various technologies promoted by their offspring and descendants [63]. In this vein, the smartphone is a suitable tool to promote self-care and a sense of security among older persons [64]. Older adults are significantly preoccupied with cybersecurity and that technology may be susceptible to malware and viruses, leading to potential hacking of their identity and personal information [65].

When receiving help with configuring their electronic devices, older people feel comfortable using technology [4] and receive encouragement from family members to enter this universe, thereby reducing self-consciousness or resistance when handling a smartphone [3]. The creation of technological products and services designed with and for older adults has a high potential to help boost the personal and social development of this population [8], anticipating various cognitive and sensorimotor limitations that arise with aging [13].

Technology can potentially support older adults in various aspects of healthy aging. Studies illustrate the opportunities offered by technology but also highlight challenges, including the dissemination of misinformation among older users [56,66]. With the increased use of digital communication during the COVID-19 pandemic, many older people adopted digital tools to communicate with others [45]. Smartphone use can also become an addiction, due to its many avenues for intrinsic gratification, including social media engagement, music consumption, and video visualization. According to Chen et al. [64], those who get pleasure from using

smartphones are more likely to have problematic smartphone use (PSU) or smartphone addiction. Likewise, individuals experiencing Fear of Missing Out (FoMO) and a need to be constantly connected are more prone to excessive smartphone use [67]. Studies have shown that smartphone overuse may serve as a coping mechanism for emotional and psychological issues, such as feelings of loneliness [68].

#### 4.1. Study limitations

The study included qualitative interviews instead of relying only on quantitative data, resulting in a more comprehensive understanding of information and a more intimate exploration of participants' real-life experiences. A single individual collected data via comprehensive interviews, and all authors conducted and validated the data analysis. Nevertheless, this research is subject to many limitations, one of which is the use of a convenience sample obtained only by telephone solicitations. Excluding those without access to this technology may result in the omission of some themes pertinent to the real-life experiences of those excluded groups. In Brazil, the telephone is often used for engaging in telemarketing fraud and deceiving or duping individuals. This may have fostered suspicion during the first encounter. Although the telephone allows for anonymity (which protects self-disclosure and emotional expression), it facilitates biased communication due to the absence of non-verbal cues. Nevertheless, its use facilitated the inclusion of a diverse range of participants from southern parts of the country, imposing little economic burden.

Despite the efforts to obtain a varied sample, the included participants did not account for all possible sources of variation that might affect digital engagement, including sex and ethnic background. Our sample only comprised smartphone users living in Paraná-Brazil, which may limit the transferability of our findings. Future research should include more geographically diverse samples because the urban areas of the south-east and south of Brazil have higher access to the internet compared to other regions [69]. Furthermore, our participants had a greater familiarity with smartphones and digital self-efficacy compared to other older adults. The use of smart technology by older persons is often influenced by their income, a significant determinant due to the associated expenses [70]. In the current study, participants did not report a relationship between smartphone use and work needs. In Brazil, age of retirement is heterogeneous, depending on the professional class, employment relationship (public or private), contributory career length and family income.

While this study offers valuable insights into older Brazilians' experiences with smartphones, there is a gap in addressing strategies to promote healthy aging in the context of smartphone use. In this sense, more public policies that endorse digital and health literacy and encourage the use of straightforward, user-friendly, and affordable digital solutions could help older adults adopt healthier lifestyles, including those with limited economic opportunities and a moderate to low level of education. Future research should seek to study more ethnically diverse perspectives, in a community-based approach, which could lead to an improved understanding of ICT's impact on healthy aging. Also, studies regarding factors impacting the adoption by seniors and caregivers of technology-enabled self-care and empowerment are needed.

Moreover, the study coincided with the pandemic period, which resulted in the alternative use of smartphones during the period of isolation. For many people, digital resources were the only way to maintain external communication, obtain information, and in some cases obtain basic survival resources [71]. Therefore, the pandemic context may have influenced the positive or negative perceptions and experiences of older adults concerning the use of smartphone technology. Longitudinal studies are needed to evaluate the long-term effects of technology on the aging process, as well as in the design of future interventions.

#### 4.2. Implications for practice

The core goal of the Decade of Healthy Ageing [9] is to enhance the well-being of older adults and promote self-sufficiency by leveraging the advantages provided by emerging technology. This study comprises important practical implications related to health promotion and the process of healthy aging mediated by technology. Smartphones play a crucial role in the lives of older individuals, serving as adaptable and indispensable instruments for doing significant tasks. They stimulated an expanded reflection on the aging process and its challenges in an increasingly connected and technological society. However, it is not appropriate to just "digitize". The instrumentation must be linked to strategies that consider the skills of older people, particularly their life stories [72]. PSU is increasing among older adults. Given the extensive use of smartphones and their possible negative consequences, to provide appropriate preventative and remedial measures, academics must comprehend smartphone usage and why it becomes problematic.

Our study identified an urgency for actions promoting intergenerational inclusion, favoring access to technological resources, professional support, and the need for specialized training, among other factors such as supporting policies that can bridge this gap. A more comprehensive vision can promote health in the long term, in addition to meeting the WHO's expectations of action toward a healthier, more inclusive, and fair aging. Training specifically aimed at mastering information and communication technologies for older people will help us understand the changes promoted by digital skills [13]. Considering the heterogeneity in the capabilities of older adults [10,54,61], training programs and support interventions must be specially designed for people in this age group, in a more person-centered perspective that optimizes the abilities and capacities of older people. Users often hold favorable views of digital health solutions but stress the significance of patient-centered and ethical design. Considering the specific requirements and abilities of older individuals when using these technologies to enhance their efficiency is essential [73].

Finally, this study contributed to an amplified understanding of emerging issues, such as the emergency use of technology by everyone during a pandemic. Thus, by answering questions and advancing scientific knowledge, one can predict situations and provide a basis for future studies and guidelines for public policies. While more studies are needed, knowledge gained through this study can inform recommendations for designing decision-support interventions to improve news reporting and reduce misinformation across

adulthood and aging.

## 5. Conclusions

This study explored how Brazilian older adults use smartphone technology in their daily lives. Specifically, our participants use their smartphones as a tool for identity construction and social promotion in the digitalization era. Three interrelated categories emerged from this study: (1) the smartphone as “a window to the world”; (2) the problem of misinformation and fake news on virtual networks; and (3) technological paradoxes in smartphone use.

The older participants in this study expressed the technology’s utility in certain tasks. According to our findings, the technology they often use greatly facilitates daily chores. However, the current use of smartphone devices might be hindered by the older adults’ lack of digital literacy and cognitive or sensorimotor impairments. They use technology to engage in many activities such as making phone calls, sending emails, capturing pictures, sharing images with acquaintances, maintaining communication with loved ones, and monitoring their health and overall state of being. Engaging in these activities and deriving pleasure from their interactions with technology is crucial for their emotional well-being. Engaging in these actions alongside cherished others enhances the emotional significance of using the technology. However, our interviewees emphasized the importance of wise and moderate use of smartphones to overcome their overuse in old age. Therefore, further research should be attentive to the overuse of smartphone devices among older adults including reduced quality of interpersonal relationships and heightened depression and anxiety.

## Funding

This work is funded by national funds through FCT—Fundação para a Ciência e a Tecnologia, I.P. (UIDB/05704/2020 and UIDP/05704/2020) and under the Scientific Employment Stimulus Institutional Call—[<https://doi.org/10.54499/CEECINST/00051/2018/CP1566/CT0012>, accessed on 20 July 2024].

## CRedit authorship contribution statement

**Adriana Martins Gallo:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Carlos Laranjeira:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Juliane Pagliari Araújo:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation. **Francielle Renata Danielli Martins Marques:** Writing – review & editing, Visualization, Validation, Methodology, Investigation. **Wanessa Cristina Baccon:** Writing – review & editing, Visualization, Validation, Methodology, Investigation. **Maria Aparecida Salci:** Writing – review & editing, Visualization, Validation, Investigation. **Lígia Carreira:** Writing – review & editing, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Conceptualization.

## Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Carlos Laranjeira reports financial support was provided by Foundation for Science and Technology. The corresponding author “Carlos Laranjeira” serves on the editorial board of Heliyon as associate editor. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.heliyon.2024.e35120>.

## References

- [1] A. Castillo, M. Rivera-Hernandez, K.A. Moody, A digital divide in the COVID-19 pandemic: information exchange among older Medicare beneficiaries and stakeholders during the COVID-19 pandemic, *BMC Geriatr.* 23 (2023) 23, <https://doi.org/10.1186/s12877-022-03674-4>.
- [2] Instituto Brasileiro de Geografia e Estatística (IBGE), Síntese de Indicadores Sociais, IBGE, Brasil, 2022. Available online: <https://www.ibge.gov.br/estatisticas/sociais/trabalho/9221-sintese-de-indicadores-sociais.html>. (Accessed 4 December 2023).
- [3] E. Balki, C. Holland, N. Hayes, Use and acceptance of digital communication technology by older adults for social connectedness during the COVID-19 pandemic: mixed methods study, *J. Med. Internet Res.* 25 (2023) e41535, <https://doi.org/10.2196/41535>.
- [4] T. Ikeuchi, S. Itoh, H. Miwa, K. Watanabe, T. Wakui, Does smartphone use make older adults feel younger? A cross-sectional online survey during the COVID-19 pandemic, *Int. J. Environ. Res. Publ. Health* 20 (2023) 1710, <https://doi.org/10.3390/ijerph20031710>.
- [5] X. Liang, F. Xiong, F. Xie, The effect of smartphones on the self-rated health levels of the elderly, *BMC Publ. Health* 22 (2022) 508, <https://doi.org/10.1186/s12889-022-12952-0>.

- [6] K.R. Haase, T. Cosco, L. Kerwin, I. Riadi, M.E. O'Connell, Older adults' experiences with using technology for socialization during the COVID-19 pandemic: cross-sectional survey study, *JMIR Aging* 4 (2021) e28010, <https://doi.org/10.2196/28010>.
- [7] T. Hailemariam, A. Atnafu, L.D. Gezie, J.J. Kaasbøll, J. Klein, B. Tilahun, Individual and contextual level enablers and barriers determining electronic community health information system implementation in northwest Ethiopia, *BMC Health Serv. Res.* 23 (2023) 644, <https://doi.org/10.1186/s12913-023-09629-8>.
- [8] Pan American Health Organization and International Telecommunication Union (PAHO and ITU), *The Role of Digital Technologies in Aging and Health*, PAHO and ITU, Washington, 2023. Available online: [https://iris.paho.org/bitstream/handle/10665.2/57344/9789275126554\\_eng.pdf?sequence=3&isAllowed=y](https://iris.paho.org/bitstream/handle/10665.2/57344/9789275126554_eng.pdf?sequence=3&isAllowed=y). (Accessed 4 December 2023).
- [9] World Health Organization, *Decade of Healthy Ageing: Baseline Report*, WHO, Geneva, 2023. Available online: <https://www.who.int/publications-detail-redirect/9789240017900>. (Accessed 4 December 2023).
- [10] A. Murciano-Hueso, A.-V. Martín-García, A.P. Cardoso, Technology and quality of life of older people in times of COVID: a qualitative study on their changed digital profile, *Int. J. Environ. Res. Publ. Health* 19 (2022) 10459, <https://doi.org/10.3390/ijerph191610459>.
- [11] K.W. Miura, S. Tokunaga, T. Sekiguchi, H. Sugimoto, M. Otake-Matsuura, Effect of home-based group conversation intervention using smartphone application on cognitive health and psychological well-being of older adults with subjective cognitive concerns in Japan: a randomized controlled trial protocol, *Front. Psychol.* 14 (2023) 1114790, <https://doi.org/10.3389/fpsyg.2023.1114790>.
- [12] G. Li, C. Jin, B. Zhao, B. Wu, Smartphone use, technology affordance for healthcare and elders' life satisfaction, *Front. Public Health* 10 (2022) 861897, <https://doi.org/10.3389/fpubh.2022.861897>.
- [13] C. Genge, H. McNeil, P. Debergue, S. Freeman, Technology to support aging in place: key messages for policymakers and funders, *Front. Psychol.* 14 (2023) 1287486, <https://doi.org/10.3389/fpsyg.2023.1287486>.
- [14] V. Stara, M. Rampioni, A. Moşoi, D. Kristaly, S.-A. Moraru, L. Paciaroni, et al., A technology-based intervention to support older adults in living independently: protocol for a cross-national feasibility pilot, *Int. J. Environ. Res. Publ. Health* 19 (2022) 16604, <https://doi.org/10.3390/ijerph192416604>.
- [15] H. Lee, J.-A. Lim, H.-K. Nam, Effect of a digital literacy program on older adults' digital social behavior: a quasi-experimental study, *Int. J. Environ. Res. Publ. Health* 19 (2022) 12404, <https://doi.org/10.3390/ijerph191912404>.
- [16] European Union, *Key Competences for Lifelong Learning*, Publications Office of the European Union, 2019. LU.
- [17] M. Schirmer, K. Dalko, D. Stoevesandt, D. Paulicke, P. Jahn, Educational concepts of digital competence development for older adults-A scoping review, *Int. J. Environ. Res. Publ. Health* 20 (2023) 6269, <https://doi.org/10.3390/ijerph20136269>.
- [18] M. Reissmann, V. Oswald, S. Zank, C. Tesch-Römer, *Digitale Teilhabe in der Hochaltrigkeit*, in: R. Kaspar, J. Simonson, C. Tesch-Römer, M. Wagner, S. Zank (Eds.), *Hohes Alter in Deutschland*, vol. 8, Schriften zur Gesundheit und Gesellschaft - Studies on Health and Society, Berlin, Heidelberg, 2023, [https://doi.org/10.1007/978-3-662-66630-2\\_7](https://doi.org/10.1007/978-3-662-66630-2_7).
- [19] K. Chen, A.H.S. Chan, Gerontechnology acceptance by elderly Hong Kong Chinese: a senior technology acceptance model (STAM), *Ergonomics* 57 (2014) 635–652, <https://doi.org/10.1080/00140139.2014.895855>.
- [20] K. Chen, V.W.Q. Lou, Measuring senior technology acceptance: development of a brief, 14-item scale, *Innovation in Aging* 4 (2020) igaa016, <https://doi.org/10.1093/geroni/igaa016>.
- [21] V. Venkatesh, M.G. Morris, G.B. Davis, F.D. Davis, User acceptance of information technology: toward a unified view, *MIS Q.* 27 (2003) 425–478, <https://doi.org/10.2307/30036540>.
- [22] M. Zhang, Older people's attitudes towards emerging technologies: a systematic literature review, *Publ. Understand. Sci.* 32 (8) (2023) 948–968, <https://doi.org/10.1177/09636625231171677>.
- [23] A. Bertolazzi, V. Quaglia, R. Bongelli, Barriers and facilitators to health technology adoption by older adults with chronic diseases: an integrative systematic review, *BMC Publ. Health* 24 (1) (2024) 506, <https://doi.org/10.1186/s12889-024-18036-5>.
- [24] K. Kim, S. Shin, S. Kim, E. Lee, The relation between eHealth literacy and health-related behaviors: systematic review and meta-analysis, *J. Med. Internet Res.* 25 (2023) e40778, <https://doi.org/10.2196/40778>.
- [25] C.I. Martínez-Alcalá, A. Rosales-Lagarde, M.D.L.A. Alonso-Lavernia, J.A. Ramírez-Salvador, B. Jiménez-Rodríguez, R.M. Cepeda-Rebollar, et al., Digital inclusion in older adults: a comparison between face-to-face and blended digital literacy workshops, *Front ICT* 5 (2018) 21, <https://doi.org/10.3389/fict.2018.00021>.
- [26] J.L. Diniz, A.C.A. Moreira, I.X. Teixeira, S.G.V. Azevedo, C.A.S.L. Freitas, I.C. Maranguape, Digital inclusion and Internet use among older adults in Brazil: a cross-sectional study, *Rev. Bras. Enferm.* 73 (2020) e20200241, <https://doi.org/10.1590/0034-7167-2020-0241>.
- [27] Y.Y. Yap, S.H. Tan, S.W. Choon, Elderly's intention to use technologies: a systematic literature review, *Heliyon* 8 (1) (2022) e08765, <https://doi.org/10.1016/j.heliyon.2022.e08765>.
- [28] K. Charmaz, Grounded theory in global perspective: reviews by international researchers, *Qual. Inq.* 20 (2014) 1074–1084, <https://doi.org/10.1177/1077800414545235>.
- [29] V.R.D.S. Souza, M.H.P. Marziale, G.T.R. Silva, P.L. Nascimento, Tradução e validação para a língua portuguesa e avaliação do guia COREQ, *Acta Paul. Enferm.* 34 (2021) eAPE02631, <https://doi.org/10.37689/acta-ape/2021AO02631>.
- [30] A.M. Gallo, J.P. Araujo, J.T.G. Siraichi, D.A. Souza, C.S. Soares, L. Carreira, Experiência com mídias sociais para ações em saúde com idosos durante a pandemia Covid-19, *REUFMS* 12 (2022) e37, <https://doi.org/10.5902/2179769268294>.
- [31] B.B. Duncan, M.I. Schmidt, E.R.J. Giugliani, *organizadores. Medicina ambulatorial: condutas de atenção primária baseada em evidências*, 3 Ed, Artmed Editora, Porto Alegre, 2004.
- [32] L.-N. Kong, N. Zhang, C. Yuan, et al., Relationship of social support and health-related quality of life among migrant older adults: the mediating role of psychological resilience, *Geriatr. Nurs.* 42 (2021) 1–7, <https://doi.org/10.1016/j.gerinurse.2020.10.019>.
- [33] C.G. Dumitache, L. Rubio, R. Rubio-Herrera, Extroversion, social support and life satisfaction in old age: a mediation model, *Aging Ment. Health* 22 (2018) 1069–1077, <https://doi.org/10.1080/13607863.2017.1330869>.
- [34] G. Liu, S. Li, F. Kong, Association between social support, smartphone usage and loneliness among the migrant elderly following children in Jinan, China: a cross-sectional study, *BMJ Open* 12 (5) (2022) e060510, <https://doi.org/10.1136/bmjopen-2021-060510>.
- [35] J.W. Creswell, *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*, third ed., Sage, London, 2013.
- [36] K. Vasileiou, J. Barnett, S. Thorpe, et al., Characterising and justifying sample size sufficiency in interview-based studies: systematic analysis of qualitative health research over a 15-year period, *BMC Med. Res. Methodol.* 18 (2018) 148, <https://doi.org/10.1186/s12874-018-0594-7>.
- [37] S.-Y. Yang, Y.-C. Wang, Y.-C. Lee, Y.-L. Lin, P.-L. Hsieh, P.-H. Lin, Does smartphone addiction, social media addiction, and/or internet game addiction affect adolescents' interpersonal interactions? *Healthcare (Basel)* 10 (2022) 963, <https://doi.org/10.3390/healthcare10050963>.
- [38] K. Charmaz, R. Thornberg, The pursuit of quality in grounded theory, *Qual. Res. Psychol.* 18 (3) (2021) 305–327, <https://doi.org/10.1080/14780887.2020.1780357>.
- [39] M.E.K. Amin, L.S. Nørgaard, A.M. Cavaco, M.J. Witry, L. Hillman, A. Cernasev, et al., Establishing trustworthiness and authenticity in qualitative pharmacy research, *Res. Soc. Adm. Pharm.* 16 (2020) 1472–1482, <https://doi.org/10.1016/j.sapharm.2020.02.005>.
- [40] M.V. Bacanoiu, M. Danoiu, New strategies to improve the quality of life for normal aging versus pathological, *Aging. J Clin Med.* 11 (2022) 4207, <https://doi.org/10.3390/jcm11144207>.
- [41] P.B.E. Da Silva, A.S. Leal, N.N. Ferraz, Usability of smartphone apps as reading aids for low vision patients, *Disabil. Rehabil. Assist. Technol.* 17 (2022) 848–852, <https://doi.org/10.1080/17483107.2020.1820086>.
- [42] Y. Lu, H. Li, N. Chen, Y. Shi, Improving smartphone reading experience for middle-aged and elderly users: the effect of font size, line spacing and stroke weight, in: P.-L.P. Rau (Ed.), *Cross-Cultural Design. Applications in Business, Communication, Health, Well-Being, and Inclusiveness*, Springer International Publishing, Cham, 2022, pp. 353–375, [https://doi.org/10.1007/978-3-031-06050-2\\_26](https://doi.org/10.1007/978-3-031-06050-2_26), 13313.

- [43] N.H.W. Ngiam, W.Q. Yee, N. Teo, K.S. Yow, A. Soundararajan, J.X. Lim, et al., Building digital literacy in older adults of low socioeconomic status in Singapore (project wire up): non-randomized controlled trial, *J. Med. Internet Res.* 24 (2022) e40341, <https://doi.org/10.2196/40341>.
- [44] R. Ji, W-c Chen, M.-J. Ding, The contribution of the smartphone use to reducing depressive symptoms of Chinese older adults: the mediating effect of social participation, *Front. Aging Neurosci.* 15 (2023) 1132871, <https://doi.org/10.3389/fnagi.2023.1132871>.
- [45] K. Kim, S.Y. Park, H.C. Kang, Smartphone proficiency and use, loneliness, and ego integrity: an examination of older adult smartphone users in South Korea, *Behav. Inf. Technol.* 40 (2021) 625–634, <https://doi.org/10.1080/0144929X.2020.1713213>.
- [46] J. Mohlman, C.H. Basch, Health-related correlates of demonstrated smartphone expertise in community-dwelling older adults, *J. Appl. Gerontol.* 40 (2021) 510–518, <https://doi.org/10.1177/0733464820902304>.
- [47] H. Hawley-Hague, C. Tacconi, S. Mellone, E. Martinez, A. Eason, F.B. Yang, et al., Can smartphone technology be used to support an effective home exercise intervention to prevent falls amongst community dwelling older adults? the TOGETHER feasibility RCT study protocol, *BMJ Open* 9 (2019) e028100, <https://doi.org/10.1136/bmjopen-2018-028100>.
- [48] A. Stevic, D. Schmuck, J. Matthes, K. Karsay, “Age matters”: a panel study investigating the influence of communicative and passive smartphone use on well-being, *Behav. Inf. Technol.* 40 (2021) 176–190, <https://doi.org/10.1080/0144929X.2019.1680732>.
- [49] G. Casanova, D. Zaccaria, E. Rolandi, A. Guaita, The effect of information and communication technology and social networking site use on older people’s well-being in relation to loneliness: review of experimental studies, *J. Med. Internet Res.* 23 (2021) e23588, <https://doi.org/10.2196/23588>.
- [50] B. Klimova, M. Valis, Smartphone applications can serve as effective cognitive training tools in healthy aging, *Front. Aging Neurosci.* 9 (2018) 436, <https://doi.org/10.3389/fnagi.2017.00436>.
- [51] T. Ikeuchi, S. Itoh, H. Miwa, K. Watanabe, T. Wakui, Does smartphone use make older adults feel younger? A cross-sectional online survey during the COVID-19 pandemic, *Int. J. Environ. Res. Publ. Health* 20 (3) (2023) 1710, <https://doi.org/10.3390/ijerph20031710>.
- [52] B. Laird, D.R. Van Tongeren, J.N. Hook, et al., Exploring user perceptions of a mobile app for religious practices, *J. Relig. Health* (2024), <https://doi.org/10.1007/s10943-024-02004-9>.
- [53] C.B. Martin, B. Hong, R.N. Newsome, K. Savel, M.E. Meade, A. Xia, et al., A smartphone intervention that enhances real-world memory and promotes differentiation of hippocampal activity in older adults, *PsyArXiv* 5 (2022), <https://doi.org/10.31234/osf.io/2fwup>.
- [54] M. Gunnes, I.C. Løe, J. Kalseth, Exploring the impact of information and communication technologies on loneliness and social isolation in community-dwelling older adults: a scoping review of reviews, *BMC Geriatr.* 24 (2024) 215, <https://doi.org/10.1186/s12877-024-04837-1>.
- [55] C.B. Martin, B. Hong, R.N. Newsome, et al., A smartphone intervention that enhances real-world memory and promotes differentiation of hippocampal activity in older adults, *Proc. Natl. Acad. Sci. U.S.A.* 119 (51) (2022) e2214285119, <https://doi.org/10.1073/pnas.2214285119>.
- [56] A. Sixsmith, B.R. Horst, D. Simeonov, A. Mihailidis, Older people’s use of digital technology during the COVID-19 pandemic, *Bull. Sci. Technol. Soc.* 42 (2022) 19–24, <https://doi.org/10.1177/02704676221094731>.
- [57] A. Haydabrus, I. Linskiy, L. Giménez-Llort, Social media use, fake news and mental health during the uncertain times of the COVID-19 pandemic in Ukraine, *Behav. Sci.* 13 (2023) 339, <https://doi.org/10.3390/bs13040339>.
- [58] D. Pehlivanoglu, N.R. Lighthall, T. Lin, K.J. Chi, R. Polk, E. Perez, B.S. Cahill, N.C. Ebner, Aging in an “infodemic”: the role of analytical reasoning, affect, and news consumption frequency on news veracity detection, *J. Exp. Psychol. Appl.* 28 (2022) 468–485, <https://doi.org/10.1037/xap0000426>.
- [59] S. Shinokawa, H. Abe, R. Takashima, R. Onishi, M. Hirano, Verification of the effectiveness of a communication application in improving social connectedness and physical health among unacquainted older men: a mixed-methods pilot study, *Int. J. Environ. Res. Publ. Health* 20 (2023) 1884, <https://doi.org/10.3390/ijerph20031884>.
- [60] Q. Ma, Ahs Chan, P. Teh, Insights into older adults’ technology acceptance through meta-analysis, *Int. J. Hum. Comput. Interact.* 37 (11) (2021) 1049–1062, <https://doi.org/10.1080/10447318.2020.1865005>.
- [61] S.S. Oh, K.-A. Kim, M. Kim, J. Oh, S.H. Chu, J. Choi, Measurement of digital literacy among older adults: systematic review, *J. Med. Internet Res.* 23 (2021) e26145, <https://doi.org/10.2196/26145>.
- [62] C. Wilson-Nash, J. Tinson, ‘I am the master of my fate’: digital technology paradoxes and the coping strategies of older consumers, *J. Market. Manag.* 38 (3–4) (2022) 248–278, <https://doi.org/10.1080/0267257X.2021.1945662>.
- [63] K. Luijckx, S. Peek, E. Wouters, “Grandma, you should do it—it’s cool” older adults and the role of family members in their acceptance of technology, *Int. J. Environ. Res. Publ. Health* 12 (12) (2015) 15470–15485, <https://doi.org/10.3390/ijerph121214999>.
- [64] C. Göransson, Y. Wengström, K. Ziegert, A. Langius-Eklöf, K. Blomberg, Self-care ability and sense of security among older persons when using an app as a tool for support, *Scand. J. Caring Sci.* 34 (3) (2020) 772–781, <https://doi.org/10.1111/scs.12782>.
- [65] B. Morrison, L. Coventry, P. Briggs, How do older adults feel about engaging with cyber-security? *Hum. Behav. Emerg. Technol.* 3 (2021) 1033–1049, <https://doi.org/10.1002/hbe2.291>.
- [66] C. Chen, K.Z.K. Zhang, X. Gong, M. Lee, Dual mechanisms of reinforcement reward and habit in driving smartphone addiction: the role of smartphone features, *Internet Res.* 29 (6) (2019) 1551–1570, <https://doi.org/10.1108/INTR-11-2018-0489>.
- [67] J.D. Elhai, J.C. Levine, R.D. Dvorak, B.J. Hall, Fear of missing out, need for touch, anxiety and depression are related to problematic smartphone use, *Comput. Hum. Behav.* 63 (2016) 509–516, <https://doi.org/10.1016/j.chb.2016.05.079>.
- [68] M. Zhitomirsky-Geffet, M. Blau, Cross-generational analysis of predictive factors of addictive behavior in smartphone usage, *Comput. Hum. Behav.* 64 (2016) 682–693, <https://doi.org/10.1016/j.chb.2016.07.061>.
- [69] L.F. Silva, E. Zitkus, A.P. Freire, An exploratory study of the use of the internet and E-government by older adults in the countryside of Brazil, *Information* 14 (4) (2023) 225, <https://doi.org/10.3390/info14040225>.
- [70] G. Dermody, R. Fritz, C. Glass, M. Dunham, L. Whitehead, Factors influencing community-dwelling older adults’ readiness to adopt smart home technology: a qualitative exploratory study, *J. Adv. Nurs.* 77 (12) (2021) 4847–4861, <https://doi.org/10.1111/jan.14996>.
- [71] C. Laranjeira, The ‘loneliness pandemic’: implications for gerontological nursing, *Br. J. Nurs.* 30 (11) (2021) 652–655, <https://doi.org/10.12968/bjon.2021.30.11.652>.
- [72] T. Schroeder, L. Dodds, A. Georgiou, H. Gewald, J. Siette, Older adults and new technology: mapping review of the factors associated with older adults’ intention to adopt digital technologies, *JMIR Aging.* 6 (2023) e44564, <https://doi.org/10.2196/44564>.
- [73] M.M. Alruwaili, M. Shaban, O.M. Elsayed Ramadan, Digital health interventions for promoting healthy aging: a systematic review of adoption patterns, efficacy, and user experience, *Sustainability* 15 (23) (2023) 16503, <https://doi.org/10.3390/su152316503>.