Original Paper

Inclusive Design Guidelines for Digital Health Interventions for Older Adults: Fuzzy eDelphi Study

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Abstract

Background: People aged 60 years and older represent a rapidly growing population worldwide. Aging is associated with complex health and social needs, and quality of life is influenced by multiple factors, including access to health care services, caregiver support, social participation, and community engagement. Digital health interventions (DHIs), such as mobile apps and wearables, have the potential to support some of these needs. However, their adoption among older adults remains limited, partly due to usability and accessibility barriers, and insufficient consideration of inclusive design principles.

Objective: This study aimed to assess expert consensus on a novel set of inclusive design guidelines for DHIs intended for older adults. An expert panel with expertise in digital health, user experience, design, and geriatrics was convened to evaluate the guidelines.

Methods: The initial guidelines were developed through a multimethod approach in previous work and comprised 13 guidelines. A 3-round eDelphi study was conducted with experts from academia, industry, and public and private health sectors. Participants rated each guideline item in terms of utility, clarity, and ease of use on a 7-point Likert scale, with responses transformed into a fuzzy scale for analysis. Consensus criteria were predefined, and the eDelphi process and reporting followed the Guidance on Conducting and Reporting Delphi Studies (CREDES). Following the eDelphi rounds,

experts contributed practical examples to support implementation of the guidelines. These examples underwent an expert review and revision process that was not formally standardized.

Results: A total of 28 experts participated in round 1, 20 in round 2, and 19 in round 3. Across the 42 guideline-by-assessment-aspect evaluations (14 guidelines evaluated for utility, clarity, and ease of use), consensus was reached for 33 (75%). All guideline items achieved consensus regarding their utility and clarity. However, approximately 65% (9/14) of guidelines did not reach consensus with respect to their ease of use. Expert feedback indicated that the absence of concrete examples was an important barrier to applying the guidelines in practice. Practical examples were therefore incorporated into the final version of the guidelines with the intention to facilitate their interpretation and application; their effect on ease of use was not formally assessed.

Conclusions: The expert panel confirmed that inclusive design of DHIs for older adults should address not only user interface elements but also broader health care, organizational, and contextual factors. Further research is needed to evaluate the guidelines in practice and determine their usability and effectiveness in the development of DHIs for older adults.

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Keywords: inclusive design; digital health interventions; older adults; inclusive design guidelines; eDelphi

Introduction

Background

Across the globe, individuals aged 60 years and older represent the most rapidly expanding segment of the population [1]. This demographic transition, commonly called population aging, involves a rising proportion and absolute number of older adults alongside a relative reduction in younger age groups [2]. The trend largely results from longer life expectancy; projections estimate that by 2050, the worldwide population aged 60 years and older will reach 2.1 billion [3]. While population aging first became apparent in high-income nations, it is now increasingly evident in low- and middle-income countries [2].

As people age, they might face various health and social considerations, some of which can be quite challenging. The quality of life of older adults is closely linked to factors such as access to appropriate health services, social participation, caregivers' support, and opportunities for meaningful involvement within their communities [4]. Moreover, older individuals face increased risks for multiple health conditions, including cognitive decline, persistent pain, and noncommunicable diseases such as cardiovascular disease, diabetes mellitus, and cancer [3,5]. Consequently, fostering health and well-being in later life is central to healthy aging [6]. Responding effectively to the complex health demands of an aging population is critical not only for personal fulfillment but also for financial stability [7].

Digital health interventions (DHIs) are defined as the application of digital technologies to provide health services, disseminate information, or offer health-related support. They provide one way to address the needs of an aging population [7]. DHIs are being developed to enhance clinical outcomes, to optimize care delivery, and to strengthen overall performance of the health care system. As such, they offer innovative, potentially cost-effective strategies to mitigate the health and social challenges faced by older adults [8]. By facilitating early identification of health conditions, supporting preventive strategies, and enabling individualized care, DHIs may also promote older adults' active participation in managing their own health [9,10]. The World Health Organization categorizes DHIs according to their function within the health system [11]. Among these are interventions designed for personal health monitoring, including mobile health (mHealth) applications, smartphone-based sensors, wearable devices, and web-based platforms. Such technologies allow older adults to track vital signs, record and manage physical activity and medication use, and manage other health-related indicators. Recent findings suggest that interest in digital technologies among older adults is increasing and that DHIs can offer benefits for this population [12,13]. Nevertheless, DHIs' effectiveness is contingent upon ensuring accessibility and usability [14,15]. However, tailoring these tools to meet age-related needs continues to be a significant developmental challenge. Applying principles of inclusive design represents a key strategy for achieving this objective [16].

Inclusive design is an approach used to design products and services that meet the needs of a diverse range of users. Inclusive design meets these needs by accounting for variations in socioeconomic background, gender, age, ethnicity, and language, among other characteristics [17]. Such an approach is especially necessary for older adults, given the absence of a single, representative profile of aging. The aging process differs across individuals and is influenced by both physical surroundings and social contexts that shape health-related behaviors and evolving needs [6]. In accordance, DHIs that incorporate inclusive design principles are more likely to meet users' needs [16]. Tools that overlook the specific capabilities and preferences of older adults risk limited usability, reduced adoption, and diminished impact among this expanding demographic group [18,19].

Previous Work and Scientific Contribution

Previous contributions have proposed several checklists and recommendations that focus on inclusive design of DHIs for older adults. Most of these contributions focus on the design of mobile applications that target older adults as users, and they primarily address interface-related aspects such as navigation, visual design, and interaction mechanisms [20-23]. For instance, Amouzadeh et al [22] provided a set of

essential design elements of mHealth applications for older adults, including simplified navigation, enlarged text and touch targets, and incorporation of assistive technologies in the DHIs to improve accessibility. In the area of accessibility, Stephens proposed a comprehensive checklist that covers accessibility needs of older adults related to vision, motor skills, hearing, and cognitive functioning [24]. Similarly, Boot et al [18] developed an extensive set of design recommendations based on the diverse needs of older adults, while Brewer [25] further expanded the field by examining accessibility in nonvisual technologies. Going beyond interface and accessibility aspects, Czaja et al [26] introduced a framework that identifies societal and contextual factors that influence the adoption of DHIs among older adult users.

Despite these valuable contributions, existing guidance remains predominantly focused on usability, user experience (UX), and accessibility at the level of the user interface. Broader technical, organizational, and ethical aspects such as the integration of DHIs into health care workflows, effective communication of DHI-related information to users and health care professionals, and meaningful involvement of older adults through co-design are often underrepresented, and their integration into a single, comprehensive framework is lacking [27]. Abhari et al [28] reported that current guidelines predominantly emphasize usability and UX of DHIs for older adults, while aspects such as integration and interoperability, data privacy and security, data quality, and long-term adoption receive limited attention in the existing frameworks and guidelines.

In response to these gaps, our work aimed to develop comprehensive inclusive design guidelines for older adults. In this context, inclusive design extends beyond the creation of accessible and usable interfaces. It also encompasses technical, organizational, contextual, and health care–related factors that influence whether older adults can access, understand, and adopt DHIs.

The initial version of the guidelines was developed using a multimethod approach. First, we conducted a scoping literature review that investigated DHIs and their inclusive design elements applied with older adult users in mind [29]. In addition, we conducted interviews with experts to collect their practical experience [30] and a focus group with older adults to identify the needs of the target user group regarding DHIs. By these 3 steps, we collected factors to be considered in the design and development of DHIs for older adults. Based on the factors, we defined the first version of guidelines in a workshop, using a nominal group technique. In this paper, we report on the process of assessing expert consensus on the guideline items through an eDelphi study and present the final version of design guidelines.

Methods

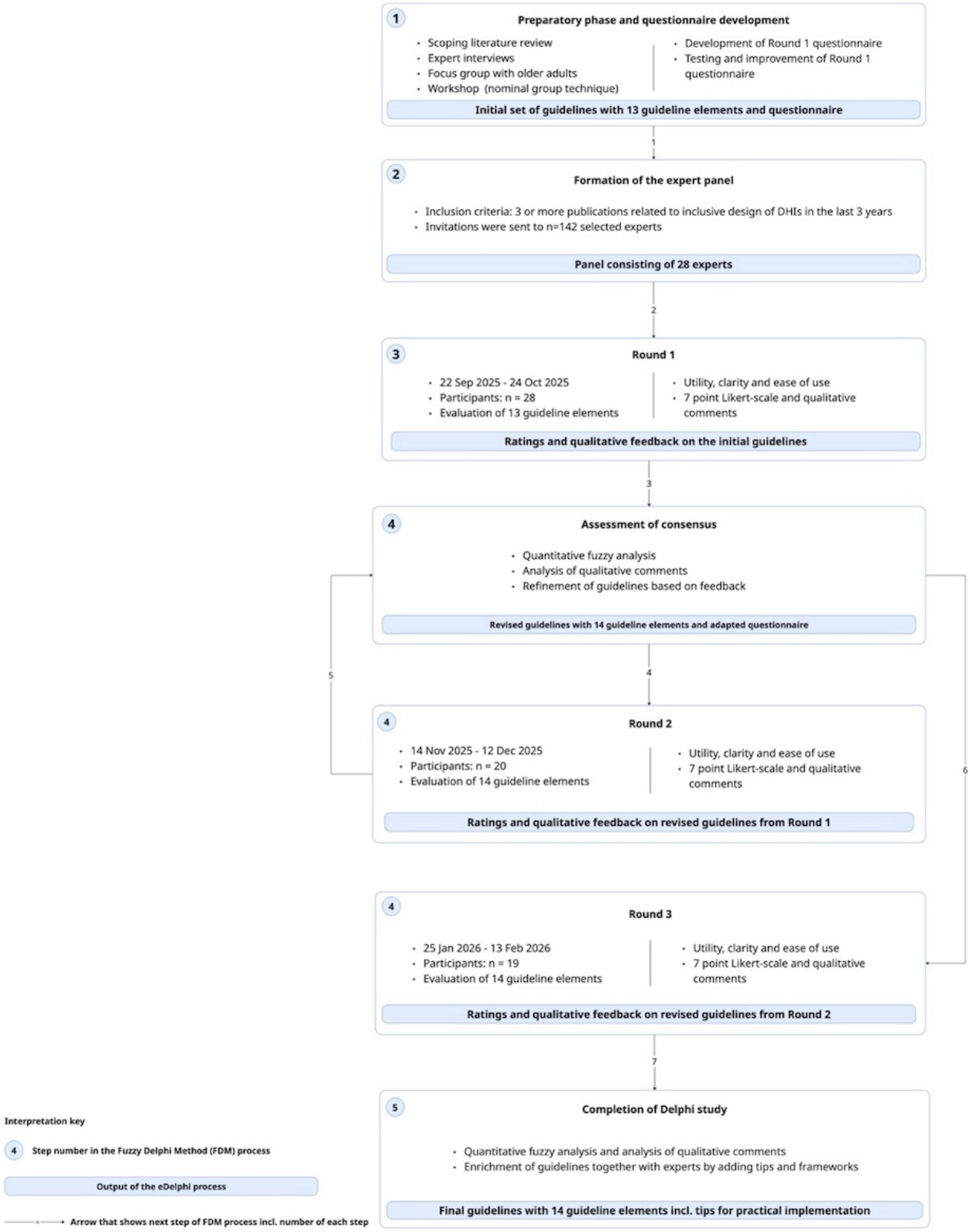
Overview of the Delphi Process

A fuzzy Delphi method (FDM) as defined by Roldán López de Hierro et al [31] was used to reach consensus on the elements of our design guideline. FDM is an adaptation of the traditional Delphi approach that incorporates fuzzy logic to better manage uncertainty and imprecision in expert assessments [31]. The use of defined fuzzy numbers allows for a more detailed and flexible representation of consensus among experts. Due to its advantages, FDM has become widely used in various fields, including health care [32-35].

Compared to the traditional Delphi Method, the FDM offers benefits, especially when it comes to handling subjectivity and uncertainty in expert feedback. While conventional Delphi techniques depend on rigid numerical scales and frequently demand multiple rounds to reach an agreement, FDM integrates fuzzy logic to capture more subtle and realistic perspectives from participants [36]. By using linguistic variables transformed into triangular fuzzy numbers, experts can share their views more flexibly, which effectively captures the natural ambiguity found in complex or delicate subjects. The FDM uses a systematic quantification process of the consensus level that minimizes the subjective interpretation and enhances the reliability of the findings [37].

Our FDM process consisted of 5 steps: (1) preparatory phase, (2) formation of the expert panel, (3) conduction of round 1, (4) assessment of consensus and conducting subsequent rounds, and (5) completion of the Delphi study (Figure 1 contains the visual overview). To organize our study, we followed the recommendations for conducting and reporting of Delphi studies [30,31].

Figure 1. eDelphi process flowchart.



Ethical Considerations

The study design was submitted to the ethics committee of the canton of Bern, which confirmed that ethics approval was not required (Req-2025-00387). The participants were informed in each questionnaire that they consent to the anonymous data analysis by submitting their responses to the questionnaire. Email addresses were only collected in rounds 1 and 2 and available to 2 coauthors (KD and ORR), who analyzed the data and shared the questionnaires with the Delphi panel. Data were stored on local machines. We followed principles

of data minimization and collected only limited demographic data in round 1.

Preparatory Phase

Development of the Initial Set of Guidelines

In the following, we refer to the term "guideline" as the individual items in our inclusive design guideline, ie, a single description of recommendations for the design and development of a DHI for older adults, together with concrete implementation guidance.

To develop the initial set of guidelines, findings from a scoping review, expert interviews, and a focus group with older adults were reviewed and organized into candidate inclusive design principles by one author (LC). Then, the initial guidelines were developed during a workshop, using the nominal group technique. Three authors (KD, LC, and BK) participated in the workshop. The workshop had the duration of 3 hours, and it began with an introduction to the workshop objectives and clarification of relevant terminology with the aim to reach the mutual understanding among participants. This was followed by a phase in which each participant independently formulated a set of guidelines. In the next step, each participant presented their proposed guidelines to the group. The candidate guideline items were then jointly compared, discussed, grouped, and mapped according to their thematic similarities. Through this discussion, participants defined a common set of guidelines and prioritized the most relevant guideline items to be included in the initial guidelines. Each candidate guideline item was considered in terms of whether it should be retained, adapted, merged with another item, removed, or reformulated as a new guideline item. In the final stage of the workshop, the selected guidelines were refined and finalized. Through this iterative process, findings from the three evidence sources were synthesized into an initial set that consisted of 13 guideline items.

We decided to split the 13 guidelines into 2 groups. One group focused on the health care ecosystem and aimed to provide a broader perspective on how DHIs can be designed for successful integration into established health care processes. It highlighted the role of health care professionals in recommending suitable DHIs to their patients. It addressed other important aspects, such as costs and support needed to enable older adults to use the DHIs confidently. These guidelines were essential to ensure that older adults have the information and support they need to engage with a DHI and integrate it into their daily routines. The 3 guidelines in this group concerned the integration of the DHI into health care processes, information about the DHI, and support, training, and peer learning.

The second group of guidelines referred to the design process of the DHI itself. This group outlined various aspects that designers and developers should consider when creating a DHI for this population. The 10 guidelines in this group concern co-design and usability testing, onboarding and in-app support, visual design and navigation, accessibility, personalization, motivation and user engagement, inclusive language and trustworthy content, social element, safety, and data security and privacy.

Questionnaire Development

The questionnaire for the first round of the eDelphi study contained the initial set of guidelines. These guidelines formed parts 1 and 2 of the first-round questionnaire. The questionnaire consisted of 5 parts:

- Part 1: Guidelines addressing societal and health care system factors (3 guidelines)
- Part 2: Guidelines addressing the design of a DHI (10 guidelines)
- Part 3: Recommended practical tools, standards, and frameworks for inclusive design (1 open question)
- Part 4: Feedback on the complete set of guidelines (intention, completeness, and missing guidelines)
- Part 5: Demographic data (gender, county of residence, field of expertise, working sector, and years of professional experience)

In parts 1 and 2, participants were shown each guideline, including its description and tips for applying it in a DHI for older adults. Following the methodology of Quiñones et al [38], the participants were asked to judge utility (This guideline is useful for designing and evaluating DHIs for older adults), clarity (This guideline is clearly formulated), and ease of use (This guideline is easy to apply in practice when working with DHIs for older adults) on a 7-item Likert scale (from "strongly disagree" to "strongly agree"). Also, the questions in part 4 followed the methodology of Quiñones et al [38]. It is worth noting that in the first round, we used the term "heuristics" rather than "guidelines" in our Delphi questionnaire. The participants' feedback led to a change in wording. To avoid confusion, we will use the term "guideline" throughout this paper. As each guideline was evaluated along 3 criteria (clarity, utility, and ease of use), we have 39 items in our consensus calculation in round 1, ie, 3 judgments for 13 guidelines.

Parts 3 and 5 of the questionnaire were used only in the first round. In the last round, we added a question about how to order the guidelines in the final version of the recommendation. A web version of the final round 1 questionnaire was created using Microsoft Forms software (Microsoft Corp). Two researchers (ORR and CP) tested its comprehensibility, usability, and accessibility using several browsers on a laptop. Issues were resolved before deployment. Microsoft Forms was also used for the round 2 and round 3 questionnaires. The participants were asked to provide their email addresses in round 1 and round 2 so they could be invited to the following round. The documentation of changes made to the questionnaire that was used to evaluate the guidelines in 3 rounds is available in Multimedia Appendix 1.

Each guideline was assessed using a 7-point Likert scale. Once the experts had completed the questionnaire, each response was converted to its corresponding fuzzy set as set out in Table 1. For example, if an expert selected a "3" as their response to the first question, the fuzzy set (0.1, 0.3, and 0.5) was used in the analysis of this first question. To this end, fuzzy numbers were used via the transformation set

out in Table 1. This transformation has been used in other FDM studies that used a 7-point Likert scale [39]. This fuzzy representation produces 3 values: the minimum, the most plausible, and the maximum. This allowed experts to select the option that best reflects their judgment [39].

Table 1. Fuzzy scale from a 7-point Likert scale.

Level of agreement	Likert scale	Fuzzy scale		
Strongly agree	7	0.9	1	1
Agree	6	0.7	0.9	1
Somewhat agree	5	0.5	0.7	0.9
Neutral	4	0.3	0.5	0.7
Somewhat disagree	3	0.1	0.3	0.5
Disagree	2	0	0.1	0.3
Strongly disagree	1	0	0	0.1

Participants

The Delphi method used a selected panel for feedback, without needing statistical representativeness. We aimed to recruit 20-30 participants from all continents except Antarctica. We considered a person eligible for joining the panel if they had 3 or more publications in inclusive design or DHIs for older adults published in the last 3 years. We aimed to include people who are currently actively contributing to the field. Therefore, we did not include anyone who published on the topic more than 3 years ago.

To identify participants for our expert panel, we considered papers published at domain-specific conferences: Medical Informatics Europe, MedInfo, the American Medical Informatics Association Annual (AMIA) Symposium for experts in digital health and medical informatics, Interact and Association for Computing Machinery Human Computer Interaction for design experts, and Gerontechnology for experts in digital solutions for older adults. We contacted all eligible people once we had identified their email addresses. In addition, people from the authors' professional network were invited to join and share the Delphi information. Participants were encouraged to invite additional participants from their networks. Invitations were emailed to 142 experts.

eDelphi Rounds

We conducted 3 eDelphi rounds, as previous research found that 2 or 3 rounds are preferable [40-42]. Round 1 began with invitations sent on September 22, 2025, and ended on October 24, 2025. Round 2 was conducted from November 14, 2025, to December 12, 2025, and round 3 ran from January 25, 2026, to February 13, 2026. Reminders were sent in rounds 2 and 3 after 1 week and 2 weeks, respectively.

We considered that a consensus had been reached when 3 conditions were met simultaneously: (1) there were no comments from the experts on the open-ended question relating to this item, (2) at least 80% of the experts agreed on the item, and (3) the threshold value (d), determined by calculation of triangular fuzzy numbers, did not exceed 0.2 [43]. The threshold value (d) used in this study represents the average distance between each expert's fuzzy value and the aggregated group fuzzy value. This approach follows the standard FDM protocol [44]. The cutoff point of the d-value is 0.20 ($d \leq 0.2$), so items with a d-value of ≤0.2 were considered to have reached a consensus [45].

Bias Prevention Measures

We decided to take several measures to minimize the potential bias throughout our eDelphi study. First, experts completed the questionnaires independently through an online questionnaire, and they did not directly interact with one another during the evaluation of the guidelines. This measure reduced the risk that dominant participants would influence the ratings of other participants. Second, the same 3 rating dimensions and 7-point Likert scale were applied consistently across all 3 rounds, and consensus criteria were defined before the analysis. Before deployment, the questionnaire was tested by 2 researchers (ORR and CP) for comprehensibility, usability, and accessibility, and identified issues were resolved before the start of the eDelphi study. Between rounds, both quantitative consensus results and qualitative comments were reviewed jointly by 3 authors (KD, LC, and BK), and modifications to the guidelines were agreed upon through discussion and consensus rather than being determined by one researcher alone. In addition, members of the panel were recruited from different disciplinary backgrounds and sectors to incorporate a wide range of perspectives and experience levels. To avoid participants only joining the Delphi study because of coauthorship, we only asked in the last questionnaire whether they wanted to contribute to paper writing and become coauthors.

Experts identified through the authors' professional networks were invited using the same recruitment procedure as other potential panel members and were subject to the same eligibility criteria and study procedures. No preferential follow-up or additional communication regarding the assessment of the guidelines was provided to these individuals. No potential conflicts of interest relevant to the assessment of the guidelines were identified among the panel members or study researchers. The 2 researchers involved in the pretest were independent of the study team and did not participate in the subsequent eDelphi panel.

Analysis and Iterative Improvement of Guidelines

Between rounds 1 and 2 and between rounds 2 and 3, three authors (KD, LC, and BK) held the review meetings to examine the quantitative consensus results and the qualitative comments provided by the expert panel. During these meetings, the authors discussed guideline items that had not reached consensus, as well as items for which participants had suggested clarification, rewording, additional content, or improved practical applicability. The quantitative findings and qualitative feedback were considered jointly, and revisions were agreed upon through discussion and consensus among the 3 authors. Based on these decisions, the wording, descriptions, and implementation guidance of the guideline items were refined before inclusion in the subsequent eDelphi round. Multimedia Appendix 1 provides a comprehensive log of the modifications made to the guideline items across the 3 eDelphi rounds.

After receiving the experts' scores for each item on the Likert scale, each Likert value was converted to the corresponding fuzzy scale value (Table 1). Thus, for an expert j and item i, we would have 3 values: $m1_{ij}$, $m2_{ij}$, and $m3_{ij}$, representing the minimum, most plausible, and maximum values. Next, the fuzzy mean values for each item were calculated from the expert's fuzzy values ($M1_i$, $M2_i$, and $M3_i$). The threshold for each item was then calculated using the following equation:

We calculated the mean d value for each item (d_i) and the percentage of experts who assigned a d_{ij} value of 0.2 or less. In addition, the fuzzy score for each item was calculated using the following equation:

This study was conducted and reported in accordance with the Conducting and Reporting Delphi Studies (CREDES) guidelines [46]. Checklist 1 presents a summary of the CREDES reporting (items 8-16) recommendations, including a reference to sections and pages of this manuscript reporting them.

Finalization of the Guidelines

The experts who assessed the guidelines in the eDelphi study were invited to develop examples for each guideline to enhance their applicability and ease of use. For each guideline, 2 experts developed examples, and an additional expert reviewed them. Experts were selected for these roles based on their professional backgrounds and areas of expertise.

The development and review of the examples were conducted remotely using an online guideline document. This process was not based on a formally standardized review procedure or prespecified review criteria; rather, reviewers drew on their professional experience and judgment to provide comments intended to improve the applicability and clarity of the examples. One author (KD) coordinated the process to facilitate the collection and incorporation of comments.

Experts who had developed the examples revised them in response to the reviewers' comments, with further exchanges taking place where considered necessary by the participating experts. Thus, although examples underwent expert review and revision, the number of review exchanges was not prespecified or systematically documented. Finally, the core team (LC, BK, and KD) reviewed the complete set of guidelines and examples.

Results

Characteristics of the Panel

The initial expert panel consisted of 28 participants who responded in the survey's first round. Of the invited experts, 19.7% (28/142) participated in round 1. Table 2 provides an overview of the participants' characteristics. There were 20/28 participants in the second round (retention rate 71.4%) and 19/20 (retention rate 95%) participants in the third round. We describe the demographics of round 1 in more depth. A total of 17/28 (60.7%) panel participants were female, 10/28 (35.7%) were male, and 1/28 (3.6%) preferred not to say. A significant number of participants (11/28, 39.3%) had 11-20 years of professional experience in their field. Several sectors were represented in the panel. Most participants (23/28, 82.1%) were from academia, and 5/28 (17.9%) were from industry. The public and private health sectors were each represented by two participants. The panel was multidisciplinary, with participants from a variety of fields. Participants could select multiple fields of expertise, as these areas often overlap in the field of eHealth. Digital health was the most frequent field of expertise (17/28, 60.7%), followed by UX and usability (13/28, 46.4%), human-computer interaction (11/28, 39.3%), gerontechnology (10/28, 35.7%), health care (10/28, 35.7%), medical informatics (9/28, 32.1%), design research (9/28, 32.1%), accessibility (8/28, 28.6%), geriatrics (7/28, 25%), and health communication (4/28, 14.3%). The panel included participants from Europe (21/28, 75%) and North America (7/28, 25%).

Table 2. Overview of participants' characteristics in the eDelphi panel[a].

Characteristic and category	Round 1[b], n (%)	Round 2[c], n (%)	Round 3[d], n (%)
Gender			
Female	17 (60.7)	12 (60)	12 (63.2)
Male	10 (35.7)	8 (40)	7 (36.8)
Prefer not to say	1 (3.6)	0 (0)	0 (0)
Experience			

Characteristic and category	Round 1[b], n (%)	Round 2[c], n (%)	Round 3[d], n (%)
<5 years	4 (14.3)	4 (20)	4 (21)
6-10 years	4 (14.3)	2 (10)	2 (11)
11-20 years	11 (39.3)	7 (35)	6 (31.6)
20+ years	9 (32.1)	7 (35)	7 (36.8)
Sector[a]			
Academia	23 (82.1)	18 (90)	17 (89.5)
Industry	5 (17.9)	1 (5)	1 (5.26)
Public health sector	2 (7.1)	1 (5)	1 (5.26)
Private health sector	2 (7.1)	1 (5)	1 (5.26)
Other	1 (3.6)	0 (0)	0 (0)
Field of expertise[a]			
Human-computer interaction	11 (39.3)	6 (30)	6 (31.6)
UX[e]/usability	13 (46.4)	8 (40)	8 (42.1)
Medical informatics	9 (32.1)	5 (25)	4 (21)
Health communication	4 (14.3)	2 (10)	2 (10.53)
Geriatrics/age studies	7 (25)	4 (20)	4 (21)
Design research	9 (32.1)	5 (25)	4 (21)
Digital health	17 (60.7)	9 (45)	8 (42)
Gerontechnology	10 (35.7)	7 (35)	6 (31.6)
Accessibility	8 (28.6)	5 (25)	4 (21)
Health care	10 (35.7)	5 (25)	5 (26.3)
Other	3 (10.7)	0 (0)	0 (0)
Continent			
Africa	0 (0)	0 (0)	0 (0)
Asia	0 (0)	0 (0)	0 (0)
Europe	21 (75)	17 (85)	16 (84.21)
Australia and Oceania	0 (0)	0 (0)	0 (0)
North America	7 (25)	3 (15)	3 (15.8)
South America	0 (0)	0 (0)	0 (0)

[a]Multiple options could be selected; percentage was calculated by n/N.
[b]Total=28.
[c]Total=20.
[d]Total=19.
[e]UX: user experience.

Resulting Guidelines

All guidelines remained in the evaluation until the final round. Although some had achieved consensus in previous rounds, the experts' comments affected them, so they were included in the list of questions for the next round. The guidelines from round 3 with a brief explanation are shown in Table 3.

Across the 3 eDelphi rounds, the set of guidelines evolved from 13 original items into 14 final guideline items, with no deletions at any stage. Round 1 framed the set as 13 heuristics (H1-H13). Round 2 reframed, restructured, and renumbered the entire set as 14 guidelines (G1-G14), introducing the standardized description/importance/implementation-tips template for every item. Four guideline titles were revised in round 2 to reflect clearer scope: G1 (Integration into health care processes → Integration into health care workflows), G4 (Co-design and usability testing → Participatory design and user involvement), G6 (Visual design and navigation → Visual clarity and navigation), and G7 (Accessibility → Accessibility and functional inclusion).

The transition from 13 to 14 guidelines is explained by a single substantive structural change: the round 1 item H10 (Inclusive language and trustworthy content) was split into 2 separate guidelines in round 2: G10 (Clarity and comprehensibility of language) and G11 (Trustworthiness). G11 is the only new item that entered the set in round 2; all other items survived as renumbered, reformulated, or retitled versions of their round 1 counterparts. The experts had repeatedly flagged this round 1 item as conflating 2 concerns; the 3 authors (KD, LC, and BK) agreed to separate the linguistic-accessibility content (G10) from the trust/credibility content (G11) before recirculation.

Round 3 retained all 14 guidelines. Thirteen were refined and clarified in wording; one was additionally retitled: G9 changed from "Motivation and user engagement" to "Motivation and sustained use of the DHI" to mark the shift

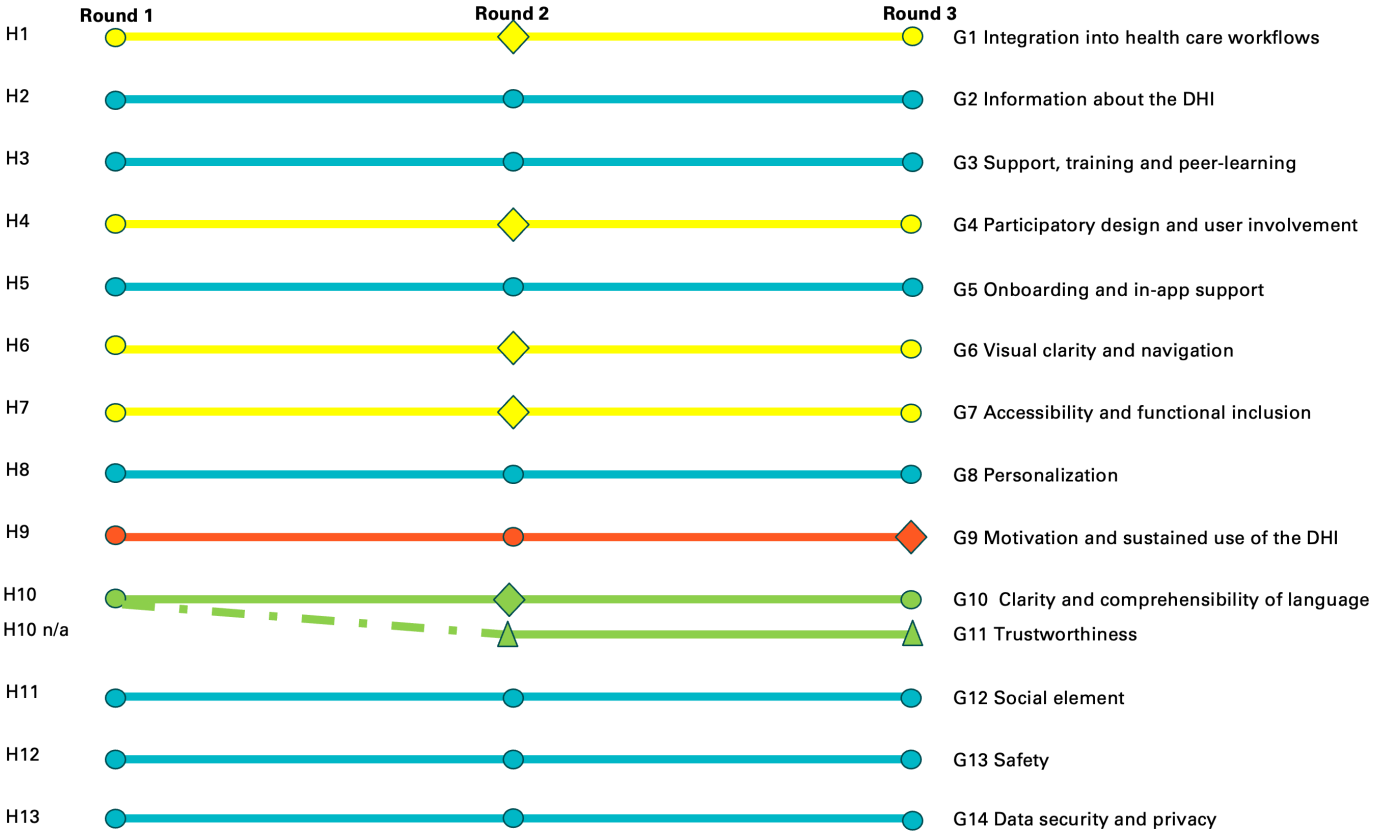
from initial adoption to long-term engagement. No item was added or removed in round 3. Every modification recorded in the change log (restructuring, retitling, splitting, and renumbering) was discussed and agreed upon by the 3 authors (KD, LC, and BK; column K of Multimedia Appendix 1) before each round closed. An overview of the changing process across the 3 rounds is provided in Figure 2.

Table 3. Guidelines in round 3 with brief explanation.

Guideline number	Guideline title	Description
Guidelines addressing the health care system factors		
G1	Integration into health care workflows	Develop a plan for integrating the DHI[a] into health care workflows and identify the added value for each stakeholder involved.
G2	Information about DHI	Provide clear, accessible information about the DHI's purpose, functionality, and limitations for older adults, caregivers, relatives, and health care professionals to promote trustworthy and evidence-based DHIs.
G3	Support, training, and peer-learning	Provide accessible and tailored support, training, and peer learning opportunities that help older adults build confidence in using the DHI.
Guidelines addressing the design of the DHI		
G4	Participatory design and user involvement	Actively involve older adults throughout all stages of the DHI development process to ensure that the solution reflects diverse needs, abilities, and experiences with technology.
G5	Onboarding and in-app support	Provide clear and accessible onboarding, in-app support, and user guides that build confidence and reduce uncertainty.
G6	Visual clarity and navigation	Design the visual interface of the DHI to be clear, consistent, and easy to navigate for older adults.
G7	Accessibility and functional inclusion	Design the DHI to be accessible and usable for older adults with diverse visual, auditory, motor, and cognitive abilities.
G8	Personalization	Design the DHI so it adapts to older adults' abilities, preferences, and goals in a way that supports autonomy and is easy to understand and control.
G9	Motivation and sustained use of the DHI	Design the DHI to include simple and culturally appropriate ways of supporting motivation and sustained use that fit the diverse lifestyles and preferences of older adults.
G10	Clarity and comprehensibility of language	Make sure that all DHI content is easy to understand, respectful, and inclusive for older adults with different levels of health literacy and language proficiency.
G11	Trustworthiness	Build and maintain trust by ensuring reliability, credibility, and transparency in all aspects of the DHI.
G12	Social element	When appropriate for the intervention's goals and context, offer privacy-preserving social features that can help older adults feel connected, supported, and motivated.
G13	Safety	Conduct a systematic risk assessment for older adult DHI users. Implement age-appropriate safety mechanisms with clear escalation pathways to prevent physical and mental harm.
G14	Data security and privacy	Integrate data security and data (processing) transparency into the DHI from the onset.

[a]DHI: digital health intervention.

Figure 2. Evolution of the 14 guideline items across the 3 eDelphi rounds. Each horizontal line represents one guideline (G1–G14). Open circles indicate unchanged titles; filled diamond markers indicate rounds in which the title was revised; the triangle denotes the new G11 (Trustworthiness) guideline created in round 2 by splitting the combined round 1 item H10. Colors track change type: blue=stable title refined each round (n=7); yellow=title revised in round 2 (n=4); green=new/split guideline originating from H10 (n=2); red=title revised in round 3 (n=1). G: guideline, H: heuristic.



The consensus results obtained in round 3 are shown in Table 4. Results from rounds 1 and 2 are provided in Multimedia Appendix 1. This table presents the scores obtained for guideline Gx, considering the 3 evaluated factors: A-utility, B-clarity, and C-ease of use. In the final round, 5 guidelines (G6, G10, G12, G13, and G14) achieved consensus and were fully accepted based on all 3 evaluated factors (utility, clarity, and ease of use). All the remaining guidelines achieved consensus and were accepted in terms of utility and clarity; however, there was no consensus regarding their ease of use. G5-C was classified as dissent, as one consensus criterion did not meet our threshold (d=0.202>.2). As we followed a strict threshold, this had to be classified as dissent.

Table 4. Fuzzy scores and agreements of each item obtained in round 3 (N=19)[a].

Items	m1 (SD)	m2 (SD)	m3 (SD)	Fuzzy score	d[b] (SD)	n (%)	Agreement
G1-A	0.795 (0.10)	0.947 (0.05)	1000 (0,0)	0.914	0.064 (0.00)	19 (100.00)	C[c]
G1-B	0.753 (0.09)	0.926 (0.05)	1000 (0.0)	0.893	0.050 (0.03)	19 (100.00)	C
G1-C	0.574 (0.24)	0.758 (0.22)	0.889 (0.17)	0.740	0.172 (0.12)	12 (63.16)	D[d]
G2-A	0.700 (0.27)	0.842 (0.29)	0.911 (0.25)	0.818	0.177 (0.20)	17 (89.47)	C
G2-B	0.684 (0.23)	0.847 (0.22)	0.937 (0.17)	0.823	0.141 (0.15)	17 (89.47)	C
G2-C	0.611 (0.22)	0.789 (0.22)	0.916 (0.17)	0.772	0.148 (0.13)	14 (73.68)	D
G3-A	0.716 (0.25)	0.858 (0.25)	0.926 (0.21)	0.833	0.159 (0.17)	17 (89.47)	C
G3-B	0.700 (0.16)	0.874 (0.13)	0.968 (0.07)	0.847	0.092 (0.09)	18 (94.74)	C
G3-C	0.579 (0.26)	0.753 (0.25)	0.879 (0.20)	0.737	0.188 (0.14)	11 (57.89)	D
G4-A	0.805 (0.12)	0.947 (0.08)	0.995 (0.02)	0.916	0.073 (0.04)	18 (94.74)	C
G4-B	0.784 (0.14)	0.932 (0.09)	0.989 (0.03)	0.902	0.083 (0.05)	17 (89.47)	C
G4-C	0.568 (0.31)	0.737 (0.29)	0.853 (0.23)	0.719	0.232 (0.14)	9 (47.37)	D
G5-A	0.784 (0.14)	0.932 (0.09)	0.989 (0.03)	0.902	0.083 (0.05)	17 (89.47)	C
G5-B	0.784 (0.14)	0.932 (0.09)	0.989 (0.03)	0.902	0.083 (0.05)	17 (89.47)	C

Items	m1 (SD)	m2 (SD)	m3 (SD)	Fuzzy score	d[b] (SD)	n (%)	Agreement
G5-C	0.642 (0.29)	0.800 (0.27)	0.895 (0.21)	0.779	0.202 (0.16)	16 (84.21)	D
G6-A	0.826 (0.12)	0.958 (0.08)	0.995 (0.02)	0.926	0.068 (0.05)	18 (94.74)	C
G6-B	0.774 (0.19)	0.921 (0.16)	0.974 (0.11)	0.889	0.097 (0.12)	18 (94.74)	C
G6-C	0.742 (0.20)	0.900 (0.16)	0.968 (0.12)	0.870	0.100 (0.12)	18 (94.74)	C
G7-A	0.742 (0.22)	0889 (0.18)	0.958 (0.12)	0.863	0.128 (0.12)	18 (94.74)	C
G7-B	0.753 (0.20)	0.900 (0.16)	0.963 (0.10)	0.872	0.117 (0.10)	17 (89.47)	C
G7-C	0.600 (0.33)	0.758 (0.31)	0.853 (0.24)	0.737	0.257 (0.13)	6 (31.58)	D
G8-A	0.711 (0.21)	0.874 (0.17)	0.958 (0.12)	0.847	0.116 (0.12)	18 (94.74)	C
G8-B	0.700 (0.20)	0.868 (0.17)	0.958 (0.12)	0.842	0.112 (0.12)	18 (94.74)	C
G8-C	0.616 (0.26)	0.789 (0.23)	0.900 (0.17)	0.768	0.184 (0.12)	10 (52.63)	D
G9-A	0.711 (0.23)	0.868 (0.19)	0.947 (0.13)	0.842	0.135 (0.13)	17 (89.47)	C
G9-B	0.668 (0.21)	0.842 (0.19)	0.942 (0.13)	0.818	0.132 (0.12)	17 (89.47)	C
G9-C	0.611 (0.27)	0.774 (0.25)	0.889 (0.19)	0.758	0.188 (0.14)	10 (52.63)	D
G10-A	0.753 (0.22)	0.900 (0.19)	0.958 (0.13)	0.870	0.120 (0.13)	17 (89.47)	C
G10-B	0.732 (0.22)	0.884 (0.19)	0.953 (0.13)	0.856	0.128 (0.13)	17 (89.47)	C
G10-C	0.695 (0.23)	0.858 (0.22)	0.942 (0.17)	0.832	0.131 (0.16)	17 (89.47)	C
G11-A	0.805 (0.12)	0.947 (0.08)	0.995 (0.02)	0.916	0.073 (0.04)	18 (94.74)	C
G11-B	0.732 (0.20)	0.889 (0.17)	0.963 (0.12)	0.861	0.110 (0.12)	18 (94.74)	C
G11-C	0.589 (0.32)	0.753 (0.30)	0.858 (0.23)	0.733	0.239 (0.14)	8 (42.11)	D
G12-A	0.742 (0.14)	0.905 (0.10)	0.984 (0.04)	0.877	0.082 (0.06)	19 (100.00)	C
G12-B	0.742 (0.14)	0.905 (0.10)	0.984 (0.04)	0.877	0.082 (0.06)	19 (100.00)	C
G12-C	0.653 (0.23)	0.821 (0.22)	0.926 (0.17)	0.800	0.151 (0.14)	17 (89.47)	C
G13-A	0.753 (0.20)	0.905 (0.16)	0.968 (0.12)	0.875	0.104 (0.12)	18 (94.74)	C
G13-B	0.684 (0.23)	0.847 (0,22)	0.937 (0.17)	0.823	0.141 (0.15)	17 (89.47)	C
G13-C	0.663 (0.27)	0.821 (0.26)	0.911 (0.20)	0.798	0.182 (0.16)	16 (84.21)	C
G14-A	0.795 (0.12)	0.942 (0.08)	0.995 (0.02)	0.911	0.074 (0.04)	18 (94.74)	C
G14-B	0.679 (0.24)	0.847 (0.21)	0.937 (0.16)	0.821	0.143 (0.14)	17 (89.47)	C
G14-C	0.679 (0.25)	0.842 (0.22)	0.932 (0.16)	0.818	0.155 (0.14)	17 (89.47)	C

[a]G (1-14) refers to the number of the guideline (Table 3); G (1-14)-A: utility, G (1-14)-B: clarity, G (1-14)-C: ease of use; m1, m2, and m3 representing the minimum, most plausible, and maximum values.
[b]d: mean threshold value.
[c]C: consent.
[d]D: dissent.

Recommended Practical Tools, Standards, and Frameworks for Inclusive Design

Overview

Experts highlighted a range of established tools, standards, and theoretical frameworks that can support the inclusive design and evaluation of DHIs for older adults. These resources span usability and accessibility standards, human-centered design approaches, behavioral models, and implementation frameworks (Textbox 1).

Textbox 1. Recommended practical tools, standards, and frameworks.

Accessibility standards
- Web Content Accessibility Guidelines, ISO standards (ISO 9241-210, ISO 21801-1:2000)
- Tool: Web Accessibility Evaluation Tool

Design frameworks
- Inclusive, universal design principles, living lab approaches
- Tool: inclusive design toolkit

Health-specific frameworks
- Reach, Effectiveness, Adoption, Implementation, and Maintenance, Xertia mHealth app guidelines, Health Cascade framework, National Institutes of Health Clear Communication principles

Human-centered design
- User- and human-centered design, co-design frameworks

Heuristics and models
- Nielsen heuristics, double diamond model structure design, Garrett 5 Planes of User Experience, design thinking

Accessibility and Usability Standards

Accessibility standards were consistently emphasized as foundational components of inclusive design. In particular, the Web Content Accessibility Guidelines (WCAG 2.1/2.2) [47,48] were frequently recommended, with experts advocating adherence to the highest conformance levels to accommodate age-related sensory, cognitive, and motor impairments. Complementary standards such as ISO 9241-210 (Human-centered design for interactive systems) [49] and ISO 21801-1:2000, which provides guidance for addressing cognitive and neurodiversity-related accessibility needs [50], were also identified as critical for ensuring usability and accessibility throughout the design lifecycle. Experts further noted the importance of incorporating redundancy in design (eg, multimodal feedback) to support users with diverse and combined impairments.

Practical tools such as the Web Accessibility Evaluation Tools [51] were recommended for assessing accessibility compliance. Experts also pointed to specific guideline sets and systematic reviews (eg, mobile app design guidelines for older adults) as valuable resources for evidence-based design decisions.

Inclusive and Human-Centered Design Frameworks

A range of inclusive design frameworks were recommended to guide the development process. These included the Inclusive Design Toolkit by University of Cambridge [52] and the Microsoft Inclusive Design Toolkit [53], both of which provide practical methods such as personas, exclusion calculators, and capability-based design approaches. The principles of universal design and broader inclusive design principles were also highlighted as essential for addressing variability in users' abilities without stigmatizing older adults.

Human-centered and participatory approaches were strongly endorsed. Experts emphasized user-centered design, human-centered design, and co-design methodologies, including living lab approaches, as critical for ensuring that DHIs reflect the real needs, preferences, and contexts of older adults. The use of persona- and scenario-based design, particularly tailored to diverse older adult populations, was recommended to support empathetic and context-sensitive design decisions.

Heuristics and Design Models

Experts suggested building on established usability heuristics, such as Nielsen heuristics [54], with adaptations to account for age-related changes (eg, enhanced feedback, reduced cognitive load, and support for recognition over recall). In addition, frameworks for persuasive and health technology design were recommended as complementary perspectives.

Design process models such as the double diamond model [55], design thinking [56], and Garrett Five Planes of User Experience [57] were identified as useful for structuring the development of DHIs. Experts also noted the importance of clearly distinguishing between design heuristics (principles) and methodological approaches (processes), as these are often conflated.

Health-Specific and Implementation Frameworks

Several frameworks specific to digital health and implementation were also identified. These included the Reach, Effectiveness, Adoption, Implementation, and Maintenance framework [58], as well as emerging models such as the Health Cascade Framework [59]. Experts referenced domain-specific guidelines such as Xcertia mHealth app guidelines [60] and emphasized the importance of health literacy frameworks, including National Institutes of Health Clear Communication principles [61]. Regulatory and ethical considerations were noted as essential components of inclusive design, with references to the General Data Protection Regulation [62] and the Health Insurance Portability and Accountability Act [63] for data protection and privacy.

Additional Considerations

Experts emphasized that inclusive design should avoid stigmatizing older adults and instead aim to create solutions that are broadly usable across age groups. They also highlighted the importance of aligning DHIs with familiar, mainstream technologies to support acceptance. Finally, the inclusion of practical examples alongside theoretical guidelines was considered essential to enhance usability and real-world applicability for designers and developers.

Discussion

Main Findings

We conducted a 3-round eDelphi study with the objective of collecting expert consensus on a first version of inclusive design guidelines. These guidelines are intended to support designers and developers in creating DHIs for older adults that are both well accepted by older adults and well-integrated into the health care system. A panel of 28 experts participated in round 1, 20 experts in round 2, and 19 experts in round 3 of the Delphi process. Consensus was reached on more than 75% (33/42) of evaluated items related to guidelines' utility, clarity, and ease of use. All guidelines achieved consensus regarding their utility and clarity. However, approximately

65% of guidelines (9/14) did not reach consensus with respect to their ease of use. Participants indicated that the guidelines were not easy to apply in practice due to the lack of examples that illustrate their real-world implementation. To address this, the panel experts enriched the final set of guidelines with examples that show how these guidelines can be implemented during the design and development stages of DHIs for older adults. In addition, existing tools and frameworks can support the implementation of some of the guidelines in practice. We included the recommended tools and frameworks wherever possible in the final version of the guidelines. The final guideline document is available in Checklist 1 and will also be made available on a webpage.

Of note, all the guidelines were considered useful to the DHI design and development processes. Considering the varied backgrounds of the experts and the range of DHIs to which the guidelines will be applied, the complete agreement on usefulness is a significant strength of the guidelines. The experts also regarded all the guidelines to be clear and understandable, which suggests that developers may be more willing to adopt them [64]. In terms of utility, experts rated the following guidelines (in order) as most relevant:

- G6: Visual clarity and navigation
- G4: Active participation
- G11: Trustworthiness
- G1: Integration into health care workflows
- G14: Data security and privacy
- G5: Onboarding and in-app support

The emphasis on navigation and integration into existing workflows is not surprising because ease of use is highly relevant to older adults who use DHIs [65]. These factors become even more important as individuals age and cognitive impairment becomes more likely and perhaps problematic in the completion of activities of daily living. Privacy and data security consistently rank among older adults' concerns related to DHIs [66,67], and failure to account for these concerns in development is likely to result in reduced acceptance and adoption. Providing personalized support at the point of use and with the opportunity for ongoing assistance when needed can help to allay deterrents to DHI use and promote regular DHI use [68].

Although the experts agreed on the usefulness and clarity of the guidelines, they did not necessarily consider all guidelines easy to apply in practice. This discrepancy suggests that a guideline can be perceived as relevant and clearly formulated while still being difficult to operationalize during the design and development of DHIs. One possible barrier is that some guidelines depend on factors that are not fully under the control of individual designers or developers, such as limited access to older adults for participatory activities, the integration of DHIs into the traditional health care workflows, limited resources of the company, institutional data governance requirements, or the availability of staff to provide training and support to older adults. The practical implementation of some guidelines may therefore require additional resources, organizational support, and improved collaboration across different professional groups within an organization. The guidelines that were considered most difficult to use, sorted by perceived difficulty, included:

- G4: Active participation
- G11: Trustworthiness
- G7: Accessibility and functional inclusion
- G3: Support, training, and peer-learning
- G1: Integration into health care workflows

Active participation was ranked second for utility and first for clarity, but it is also considered the most difficult guideline to use. Including older adult users in the development of DHIs is not always possible due to lack of proximity to DHI development facilities, users' cognitive impairment, lack of motivation to be involved, and other reasons [69]. Co-design initiatives may also involve costs (eg, transportation, personal care attendant, and special meals) that are prohibitive in some settings. When co-design is infeasible, use of a participatory design framework such as those developed by Shah et al [70] and Denecke et al [71] could support active participation.

Trustworthiness has been identified as a concern among users of health care technologies. Its abstract nature compared to other guidelines (eg, those for accessibility for users with visual or hearing limitations and DHI training) can make trustworthiness difficult to illustrate. Use of other guidelines to promote ease of use and rapid success may encourage users to trust DHIs even when efforts to demonstrate trustworthiness are not readily apparent. In addition, the trustworthiness guideline could be complex to apply because there is a lack of design frameworks that elucidate how to evaluate this subjective concept.

Support and peer-learning opportunities may be limited or infeasible in some settings, such as skilled nursing facilities, and care team members may reasonably prioritize providing health care services over DHI support. In institutional care settings, such limitations are closely linked to data governance and privacy constraints. Greater institutional control over workflows and integration with medical devices could be implemented through robust privacy-preserving frameworks, and it may enable care teams to better align DHIs with existing practices. Such developments could potentially enhance not only the feasibility of guideline implementation but also the overall quality of care and continuity of support for older adults. However, achieving this would require careful consideration of ethical, legal, and organizational responsibilities. Similarly, care team members may have no control over workflows in use and may be unable to coach older adults in using DHIs along with medical devices. Frameworks such as the normalization process theory may provide guidance in some situations but are unlikely to be a good fit for every use case [72].

Positioning the Guidelines Within Broader Age-Friendly and Inclusive Design Research

Our inclusive design guidelines can also be positioned within the broader literature on digital literacy and inclusive design for older adults. For instance, Shi et al identified that sociodemographic characteristics, device-related factors, and

social support are important influences on older adults' digital health literacy [73]. These findings support our broader understanding of inclusive design for older adults, according to which older adults' engagement with DHIs is shaped not only by the usability and accessibility of the user interface but also by their individual capabilities, access to appropriate devices, and social factors (eg, cultural context, social support, peer learning, and training opportunities). Similarly, Dong et al found that interventions aimed at improving digital health literacy can positively affect older adults' health status and health management [74]. These findings indicate that inclusive DHIs should not only reduce the interaction barriers but should also support users in accessing, understanding, and applying information that is distributed by the DHIs. In accordance, our guidelines addressed user support, training, and education, and they highlighted the importance of considering different levels of digital literacy among older adults when creating the DHIs. This might contribute to older adults' meaningful and sustained engagement with DHIs. The relevance of a multidimensional approach is also reflected in inclusive design research beyond the area of digital health. For example, Shi et al [75] developed a multidimensional index for inclusive age-friendly transit design that translates broad age-friendly principles into assessable dimensions and practical scenarios. Although it was developed for public transportation context, this approach illustrates how inclusive design should move beyond general principles toward a structured framework that supports practical implementation. Our guidelines pursue a similar objective in the context of the design and development of DHIs. This was achieved by consolidating user-related, interface-level, technical, organizational, ethical, and contextual factors into guidelines with examples for practical implementation for the design and development of DHIs for older adults. In this way, our work contributes to the translation of inclusive design principles into concrete considerations that can guide researchers, designers, developers, and further health care stakeholders in the creation of DHIs for older adults.

Planned Dissemination of the Guidelines

To support their uptake by academia and industry, the final guidelines will be made openly available through this publication and a dedicated website (milestone 1). The primary target audiences include researchers, designers, and developers of DHIs, health care professionals involved in the implementation of DHI, and organizations working in digital health, human-computer interaction, gerontechnology, and inclusive design. Dissemination will be coordinated by the study team and will initially take place following publication through scientific conferences, academic and professional networks, and relevant professional communities. Where possible, organizations and networks represented by members of the expert panel will be approached to support dissemination within their respective communities.

As an initial real-world application, the guidelines will inform the ongoing design and development of a DHI aimed at supporting the mental well-being of older adults transitioning from working life to retirement (milestone 2). This application will provide the first opportunity to examine the practical usability of the guidelines in a real-world design process, including whether and how the practical examples support their interpretation and ease of use. It will also enable the identification of challenges arising during their implementation. Feedback and experiences from this application will be documented and considered in future revisions of the guidelines.

The reach and uptake of the guidelines will be monitored, where feasible, using indicators such as website access or downloads, citations of the publication, and documented use of the guidelines in research or development projects. In addition, feedback submitted through the dedicated forum will provide a mechanism for users to report experiences, suggest modifications, or identify emerging evidence relevant to individual guideline items. The guideline set is intended to evolve as new evidence and practical experience emerge. The study team will remain responsible for maintaining the online version and reviewing relevant feedback and new evidence at defined intervals (eg, two years and follow-up milestones). Revisions will consider emerging research, feedback from users, and findings from applications of the guidelines in practice. Substantive updates will undergo review by relevant experts and stakeholders before being incorporated into a revised version, and changes between versions will be documented transparently. Future evaluations should particularly involve older adults, health care professionals, designers and developers, and stakeholders from geographical and cultural contexts that were underrepresented in this study.

Limitations

We acknowledge that the presented eDelphi study has several limitations. First, the geographical representation of the expert panel was limited. All experts were based in Europe or North America, while no experts from Africa, Asia, South America, or Australia and Oceania participated. This imbalance may partly reflect the recruitment strategy we used, which relied primarily on conferences, publications, organizations, and professional networks that are based in Europe and North America. The low response rate could be explained by the recruitment strategy: collecting email addresses from papers may lead to outdated or inactive contact information and may also result in unsolicited invitations being overlooked or filtered as spam. However, we are lacking information on why people were not responding to the request to join the Delphi panel. The survey was conducted in English, which may have introduced language bias by limiting participation to experts with sufficient English proficiency and potentially affecting participants' interpretation of the guideline items and survey questions. The disciplinary and sectoral composition of the panel may also have influenced the findings, as expertise was more strongly represented in digital health, UX/usability, and human-computer interaction than in areas such as geriatrics and health communication, potentially giving greater weight to technology- and design-oriented perspectives. Persons with lived experiences remained unconsidered. Some experts were recruited through the authors' professional networks. Although these experts underwent the same

recruitment and study procedures as other panel members, recruitment through existing professional relationships may have introduced selection bias, for example, by increasing the likelihood of including experts with professional perspectives or research interests similar to those of the study team.

Consequently, the consensus that was reached in this eDelphi study should be interpreted primarily within the European and North American contexts represented by the panel. The findings may not fully reflect the differences in healthcare systems, digital infrastructure, socioeconomic conditions, cultural expectations regarding aging and care, language, and levels of digital and health literacy across other world regions. Therefore, the guidelines cannot yet be considered globally validated. Future studies should assess and adapt the guidelines with experts, older adults, health care professionals, designers, and other stakeholders from underrepresented regions and evaluate their applicability across diverse cultural, socioeconomic, and health care contexts.

Furthermore, this study collected only expert consensus and lacks external validation of the guidelines. We did not include an assessment by older adults nor conduct testing of the guidelines in real-world design and development settings. Although older adults' perspectives informed the development of the initial set of guidelines through a focus group, their involvement was limited to this earlier phase. Therefore, future studies should evaluate the guidelines with older adults, caregivers, healthcare professionals, and DHI developers and examine their practical applicability during the design, development, and evaluation of DHIs.

In addition, even after 3 eDelphi rounds, not all guidelines achieved full consensus, particularly regarding their perceived ease of use. In response to this concern, experts from the panel were further involved in refining the guidelines and developing practical examples intended to facilitate their use.

However, although the examples underwent review and revision by participating experts, this process was not formally standardized and relied on their professional experience and judgment. Moreover, the participating experts were also coauthors of this study, and the examples may therefore reflect a limited range of perspectives. Although the examples were developed with the intention of improving ease of use, we did not formally assess whether they achieved this aim. Consequently, the extent to which the examples improve the ease of use of the guidelines remains uncertain. Future research should independently evaluate the guidelines and examples with relevant stakeholder groups, including designers, developers, and health professionals.

Finally, the nature of the eDelphi methodology relies on online data acquisition and limits the direct interaction among participants. The absence of discussion may have restricted opportunities to clarify different perspectives or resolve disagreements in greater depth. While this approach reduces the risk of dominant voices influencing the process, it may also limit the richness of consensus compared to more interactive methods.

Conclusions and Outlook

In this eDelphi study, we assessed expert consensus on a set of inclusive design guidelines for DHIs intended for older adults. The framework extends beyond user interface considerations to address health care, organizational, and contextual factors relevant to DHI design. Consensus was achieved for most items, with all guidelines rated as useful and clear. This consistent agreement across experts with diverse backgrounds underscores the framework's relevance, comprehensibility, and potential for adoption in practice.

Guidelines related to visual clarity and navigation, active participation, trustworthiness, workflow integration, data security, and onboarding were rated as most relevant, reinforcing the importance of usability, safety, and contextual fit in DHIs for older adults. These priorities align with the known needs of this population, including minimizing cognitive burden, addressing privacy concerns, and ensuring seamless integration into daily routines and care processes.

However, several guidelines did not reach consensus on ease of use, highlighting a gap between perceived value and practical implementation. In particular, active participation and trustworthiness, despite being highly valued, were seen as difficult to operationalize due to barriers such as limited access to users, resource constraints, and the abstract nature of certain ideas. Challenges related to workflow integration and support provision further reflect structural limitations within care settings. These findings indicate that additional methodological and practical guidance is needed, including participatory design approaches, clearer operationalization of complex concepts, and context-sensitive implementation strategies.

Overall, the guidelines bring together interface-level considerations with broader factors such as accessibility, interoperability, sustained use, safety, trustworthiness, and integration into health care processes, providing an expert-informed framework for DHI design and development. Their practical usability, applicability across settings, and contribution to the development of inclusive and accessible DHIs remain to be evaluated empirically. Further studies should evaluate the transferability of the guidelines across diverse health care systems, geographical or cultural contexts, as well as types of DHIs.

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Generative AI Use

Generative AI (ChatGPT OpenAI, models GPT-4o and GPT-5) was used to assist with language editing of the manuscript draft. No AI tool was used to generate original scientific content. AI was also not used to design the study, formulate research

questions, extract data, or perform statistical analysis, and AI did not independently determine the interpretation, conclusion, or scientific claims of the study. The authors take full responsibility for the accuracy, integrity, and final content of the manuscript.

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Data Availability

All available data are provided as Multimedia Appendices 1 and 2 and Checklist 1.

Authors' Contributions

Conceptualization: KD, ORR
Methodology: KD, ORR, LC, BK
Data analysis: ORR, KD
Writing (original draft): KD, ORR, LC, CP, EZ
Writing (review & editing): BK, ORR, KD, CP, EZ, YA, LC, JSA, MB-H, RD, JG-D, LH, MO, VS, ES, GV, TV, EDZ
Participation in eDelphi panel: EZ, YA, JSA, MB-H, RD, JG-D, LH, MO, VS, ES, GV, TV, EDZ

Conflicts of Interest

None declared.

Multimedia Appendix 1

Inclusive design guidelines and questionnaire modification log, including fuzzy scores and agreements of each item obtained in round 1, round 2, and round 3.
[XLSX File (Microsoft Excel File), 49 KB-Multimedia Appendix 1]

Multimedia Appendix 2

Inclusive design guidelines.
[PDF File (Adobe File), 1201 KB-Multimedia Appendix 2]

Checklist 1

Filled Conducting and Reporting Delphi Studies reporting guidelines.
[DOCX File (Microsoft Word File), 2038 KB-Checklist 1]

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Abbreviations

AMIA: American Medical Informatics Association
CREDES: Conducting and Reporting Delphi Studies
DHI: digital health intervention
FDM: fuzzy Delphi method
mHealth: mobile health
UX: user experience
WCAG: Web Content Accessibility Guidelines

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