

Understanding the Thoughts and Preferences of Older Adults for Technologies Designed to Detect Feelings of Loneliness: A Qualitative Study

Jessica Rees, John Ratcliffe, Wei Liu, Yi Zhou, Sebastien Ourselin, Michela Antonelli, Ashay Patel, Yu Shi, Jingqi Liu, Anthea Tinker, Faith Matcham

Submitted to: JMIR Human Factors
on: March 10, 2025

Disclaimer: © The authors. All rights reserved. This is a privileged document currently under peer-review/community review. Authors have provided JMIR Publications with an exclusive license to publish this preprint on its website for review purposes only. While the final peer-reviewed paper may be licensed under a CC BY license on publication, at this stage authors and publisher expressly prohibit redistribution of this draft paper other than for review purposes.

Table of Contents

Original Manuscript.....	5
---------------------------------	----------

Preprint
JMIR Publications

Understanding the Thoughts and Preferences of Older Adults for Technologies Designed to Detect Feelings of Loneliness: A Qualitative Study

Jessica Rees¹ PhD; John Ratcliffe²; Wei Liu³; Yi Zhou³; Sebastien Ourselin⁴; Michela Antonelli⁴; Ashay Patel⁴; Yu Shi⁵; Jingqi Liu⁵; Anthea Tinker¹; Faith Matcham⁶

¹ Institute of Gerontology King's College London London GB

² School of Healthcare University of Leeds Leeds GB

³ Department of Engineering King's College London London GB

⁴ School of Biomedical Engineering & Imaging Sciences King's College London London GB

⁵ School of Design University of Leeds Leeds GB

⁶ School of Psychology University of Sussex Falmer GB

Corresponding Author:

Wei Liu

Department of Engineering
King's College London
Strand Building
London
GB

Abstract

Background: Loneliness is a negative emotional state which is common in later life. The accumulative effects of loneliness have significant impact on physical and mental health of older adults. Automatic methods for detection and prediction are an emerging field to support early identification of loneliness.

Objectives: We aim to qualitatively explore the thoughts and preferences of people aged 65 and over regarding technologies to detect feelings of loneliness in later life.

Methods: We conducted 60 semi-structured interviews with people aged 65 and over between September 2022 and August 2023. Data were analysed using a reflective thematic approach on NVIVO software.

Results: Three themes were identified representing what older adults considered important in a system able to detect loneliness. 1) Interest and Control of Data, which was a priority for older adults; 2) Perceived Usefulness to Address Loneliness, which related to the importance of providing recommendations to reduce feelings of loneliness after detection; and 3) Personalisation as a Priority, which included the level of loneliness for which an alert was sent and selection of relevant individuals who would be sent a loneliness alert.

Conclusion: Findings from this in-depth qualitative study provide important perspectives from people with lived-experience of loneliness on the context in which a sensor-based loneliness detection system would be most useful and acceptable to older adults. Future research will include such perspectives in the design of innovative technologies enabling the early detection of loneliness and access to timely interventions to tackle loneliness in later life.

(JMIR Preprints 10/03/2025:73694)

DOI: <https://doi.org/10.2196/preprints.73694>

Preprint Settings

1) Would you like to publish your submitted manuscript as preprint?

✓ **Please make my preprint PDF available to anyone at any time (recommended).**

Please make my preprint PDF available only to logged-in users; I understand that my title and abstract will remain visible to all users.

Only make the preprint title and abstract visible.

No, I do not wish to publish my submitted manuscript as a preprint.

2) If accepted for publication in a JMIR journal, would you like the PDF to be visible to the public?

✓ **Yes, please make my accepted manuscript PDF available to anyone at any time (Recommended).**

Yes, but please make my accepted manuscript PDF available only to logged-in users; I understand that the title and abstract will remain visible to the public.

Yes, but only make the title and abstract visible (see Important note, above). I understand that if I later pay to participate in a JMIR journal, I will be able to make my accepted manuscript PDF available to anyone.

No. Please do not make my accepted manuscript PDF available to anyone.



Original Manuscript

Understanding the Thoughts and Preferences of Older Adults for Technologies Designed to Detect Feelings of Loneliness: A Qualitative Study

Abstract

Background: Loneliness is a negative emotional state which is common in later life. The accumulative effects of loneliness have significant impact on physical and mental health of older adults. Automatic methods for detection and prediction are an emerging field to support early identification of loneliness.

Objectives: We aim to qualitatively explore the thoughts and preferences of people aged 65 and over regarding technologies to detect feelings of loneliness in later life.

Methods: We conducted 60 semi-structured interviews with people aged 65 and over between September 2022 and August 2023. Data were analysed using a reflective thematic approach on NVIVO software.

Results: Three themes were identified representing what older adults considered important in a system able to detect loneliness. 1) Interest and Control of Data, which was a priority for older adults; 2) Perceived Usefulness to Address Loneliness, which related to the importance of providing recommendations to reduce feelings of loneliness after detection; and 3) Personalisation as a Priority, which included the level of loneliness for which an alert was sent and selection of relevant individuals who would be sent a loneliness alert.

Conclusion: Findings from this in-depth qualitative study provide important perspectives from people with lived-experience of loneliness on the context in which a sensor-based loneliness detection system would be most useful and acceptable to older adults. Future research will include such perspectives in the design of innovative technologies enabling the early detection of loneliness and access to timely interventions to tackle loneliness in later life.

Introduction

Loneliness is widely acknowledged to be a serious public health matter [1]. Definitions of loneliness vary, but most authors agree that it refers to a negative emotion linked to poor quality and/or insufficient social relationships [2–4]. This is usually placed as distinct from social isolation, which refers to an ‘objective’ lack of social relationships. The consequences of loneliness can include poor mental health [5], risk of Alzheimer’s disease [6], and increased mortality [7]. Ageing has long been recognised as associated with loneliness [8], with later life even being expected to be a ‘time of loneliness’ [9]. In the UK, as many as one in four people over the age of 65 are experiencing moderate to high loneliness [10]. Age-related changes such as retirement, bereavement, reduced social networks, and loss of mobility are well evidenced as risk factors for loneliness [8,11–14].

Technology has also been lauded for its potential to aid people in maintaining existing relationships

and increasing communication with neighbours, family, and friends [16]. However, work has identified a multitude of barriers to uptake [17] including trust in the technology [18], a lack of design with older people in mind [19], and family caregiver concerns related to acting upon risks detected by technologies [20]. Issues of data protection, privacy, and control have been recorded in numerous studies looking at the use of digital technologies in health [21]. Automated technologies have the potential to challenge autonomy, particularly if it notifies other people without the immediate consent of the older adult being monitored [22]. Ageism can result in marginalisation and feelings of powerlessness [23] and loneliness has been placed as a marginalising stereotype of age as well as a real concern [24] therefore addressing such ethical concerns are paramount to the design of future technologies.

In recent years, using smart technology to identify loneliness has emerged as a potentially useful method of tackling loneliness in older adults [25]. Several physiological and behaviours indicators of loneliness have been established including stress, sleep and activity levels enabling the passive detection using technologies [26,27]. Specifically, sensor-based approaches measuring behavioural markers of social isolation such as physical inactivity, poor sleep quality, eating behaviours, time out of home and phone usage [28]. Numerous works have relayed instances of successful using machine learning algorithms able to predict emotions using data such galvanic skin response [29], electrocardiogram data [30] and electroencephalography data [31]. Behavioural data has also been applied to predicting loneliness [17,28,32]. For example, one scoping review found studies measuring daily life patterns to detect loneliness using ‘smart’ technology (e.g., ambient sensors to measure motion and touch), smartphones, and wearable sensors [18]. Another review of technology aimed at preventing loneliness in older people found that approaches measuring behaviour and movement showed promise as they are usually successful at identifying loneliness [25].

The association between physiological markers of loneliness and need to tackle loneliness in older populations suggests that it may be fruitful to construct technology capable of identifying loneliness in older adults [33]. Such technologies are required to be both useful and acceptable to older adults to be effective in supporting the reduction of feelings of loneliness. Relevant theoretical frameworks suggest that for technology to be accepted and used by older adults it must be perceived as easy, useful and users must have appropriate support and resources [34]. The current study aims to gain insight into older adults’ general acceptance of loneliness detection technologies to identify the most meaningful priorities for this population applicable for future technology development.

The potential to detect loneliness in older adults has numerous potential benefits. A wealth of evidence has suggested that loneliness may be a stigmatised condition [35]. Such negative

desirability bias means the ability to detect loneliness without a person needing to seek help may be particularly useful [36]. This may be particularly useful for older men who do not identify as lonely but suffer consequences of a similar nature [37]. Timely and accurate identification of loneliness in older adults will enable people to receive the right kind of support at the right time [32]. In general, approaches to alleviate loneliness in older adults include leisure activities (i.e. gardening, music, exercise), therapies (i.e. animal, reminiscence, cognitive), social and community interventions (i.e. meal sharing), educational approaches (i.e. relationship or skills training), befriending, or system wide approaches [38]. Such activities can be made available to older adults through referral by primary care professionals through social prescribing initiatives [39].

The current paper is part of the 'Design for Healthy Ageing (DELONELINESS)' project that aims to develop a smart monitoring and communication system with multi-functional electronics built into textiles used as wearables and home furniture to detect and measure loneliness levels in later life [32]. As outlined in Figure 1, this system will involve the detection of physiological and behavioural indicators of loneliness in later life using sensor-based technologies. Such technologies will be worn by people aged 65 and over with data being inputted into an algorithm modelled to predict feelings of loneliness. Once loneliness is identified, the aim would be to enable users to receive the support from family and/or health and social care professionals or promote engagement in activities to alleviate feelings of loneliness. Further details have been outlined in previous publications [32].

Including the perspectives of older people is central to the design of such a system [40]. In the current paper, we present our qualitative findings on the thoughts and preferences of older adults on technologies designed to monitor and detect feelings of loneliness. Our specific objectives are to:

1. Describe the context and circumstances in which a smart system might be most useful; and
2. Identify the most meaningful way of providing information back to individuals, their carers, or healthcare/ social service providers.

Methods

Study design

One-to-one semi-structured interviews were conducted with participants aged 65 and over on their experiences of loneliness and preferences for loneliness detection technologies. Ethical approval was obtained from Research Ethics Committees at Kings College London (reference number: LRS/DP-21/22-33376) and the University of Sussex (reference number: ER/JH878/1). Detailed methodology employed in this study is available in the published protocol [41].

Recruitment

A stratified sampling technique based on age, gender, accommodation type (own home, rented,

sheltered accommodation) and level of digital ability were employed. We used the communication preferences of participants during the recruitment process (i.e. if older adults had an email, mobile phone, or a landline number) as a proxy measure for level of digital ability. Eligible participants were required to be aged 65 and over, have experienced loneliness since reaching age 65, be able to give informed consent, and speak English at a level fluent enough to take part in the interview. Study information was disseminated via research participant websites, organisation newsletters related to housing, and in communication to individuals from previous research projects (related to depression, and ageing) who consented to being contacted about future studies. Interested individuals were invited to contact the research team to obtain study details. All participants provided written informed consent prior to data collection.

Data collection

Interviews were conducted between September 2022 and August 2023 by a female qualitative researcher and chartered psychologist with expertise in sensitive interviewing. According with participant preferences, interviewed were conducted either in-person (at home or in university offices) or remotely (via telephone or video call using Microsoft Teams software). Sociodemographic data including severity of loneliness experienced by participants using the de Jong Gierveld Loneliness scale [42] which has 11-items related to social and emotional loneliness which are totalled to obtain an individual's level of loneliness (i.e. not lonely, moderately lonely, severely lonely, very severely lonely).

The interview topic guide was developed by a multi-disciplinary team of psychologists, gerontologists, product designers and machine learning experts. The first part of the interview focused on the subjective experiences of participants to identify the signs and associated behaviours with loneliness in later life. Findings from this section of the interview have been previously published [33]. The latter half of the interview focused on participants thoughts and preferences on the role of technology to detect loneliness.

In relation to technology, we asked about participants existing use of technologies in relation to their health. We then introduced proposed technologies for measuring loneliness, for example sensors worn on the body or integrated into a fabric which collect physiological data which may be of relevance of loneliness (i.e. heart rate, activity levels). We asked participants- where on their body or in their home would they be willing to have a device. Finally, we asked about data collected by loneliness detection technologies. Specifically, we asked how useful they would find data collected by the system (i.e. sleep, movement, stress levels) and if this data could be sent to anyone to improve participants quality of life. We then asked about the benefits and limitations of the data to

participants, family members and healthcare professionals. Lastly, we asked about participants thoughts on receiving an alert to the risk of becoming lonely, and what participants would hope family members or healthcare professionals would do if they received a loneliness alert. See Appendix 1 for full interview schedule.

Participants received at £30 LoveToShop voucher at the end of the interview as a thank you for sharing experiences for the study. Interviews were audio recorded and transcribed verbatim by a professional company.

Analysis

Data were analysed using a reflexive thematic approach [44]. The early structured themes were constructed by identifying ‘semantic’ themes – surface level ideas built from the stated perspectives of the participants, but which are not thoroughly interrogated [45]. The generation of initial codes were generally grouped in line with the topic guide questions, for example usefulness of data, benefits and limitations to data, and thoughts on loneliness alert. Themes were grouped into the perspectives of ‘older adults’ ‘family members’ or ‘healthcare professionals.’ These were transformed into ‘reflexive’ themes through several intertwined processes. Specifically, we wrote up ‘semantic’ themes fully into a report which was then shared with the multidisciplinary project team and discussed in team meetings. Themes were reviewed a final time by the second author who was involved in drafting this article but was not present during data collection and analysis. To facilitate an iterative process of theme building and refinement, the themes were critically contrasted with extant literature [46] specifically the literature on interventions for reducing loneliness. In addition, to extrapolate information on ‘what works for whom in which contexts’ [47] participant characteristics, specifically level of loneliness, marital status and accommodation type were considered throughout the write up stage.

Results

Participant Characteristics

60 older adults were interviewed with a mean age of 73, ranging from 65 to 91. Most participants were aged between 65 and 74 years, female, white British, homeowners, with a moderate level of loneliness. See Table I for full details.

Marital status varied from Widowed ($n = 20$), Divorced ($n = 16$), Single ($n = 11$), Married ($n = 8$) and Separated ($n = 5$). The frequency of loneliness also varied from Often/ Always ($n = 23$), Occasionally ($n = 16$), Some of the time ($n = 20$) and Never ($n = 1$). Most participants were degree educated ($n = 34$). Thirty per cent of participants did not have children ($n = 18$) and 13% did not have anyone to contact if they were in trouble of needed help ($n = 8$). The majority of participants reported having a long-standing illness or disability ($n = 50$) such as depression, chronic fatigue, arthritis or hearing

loss. Five participants communicated using their landline number only.

Table 1. Characteristics of participants

	Characteristics	Number of participants
Age	65-74	42 (70%)
	75+	18 (30%)
Gender	Female	42 (70%)
	Male	18 (30%)
Ethnicity	White/White British	54 (90%)
	Black/Black British	3 (5%)
	Asian/Asian British	3 (5%)
Loneliness level (De-Jong-Gierveld scale)	Not lonely	3 (5%)
	Moderate	36 (60%)
	Severe	10 (17%)
	Very severe	11 (18%)
Accommodation type	Own home	43 (72%)
	Rented	10 (17%)
	Sheltered accommodation	7 (11%)

Themes

Three themes were constructed to represent older adults' thoughts and concerns regarding a loneliness detection device. 1) 'Interest and control of data' outlined the characteristics of older adults interested in a loneliness detection system and the importance of retaining control over data collected to detect loneliness. 2) 'Perceived usefulness to address loneliness' highlighted the need to provide suggestions to reduce loneliness in conjunction with alert about loneliness. 3) 'Personalisation as a priority' relays how participants felt the system needed to be tailored to individuals, particularly regarding a) the level of loneliness that required intervention and, b) who the participants felt should be informed they are lonely.

Theme 1: Interest and control of data

Older adults spoke about how health data collected by the system (i.e. heart rate, sleep, activity levels) were interesting, comforting, reassuring and empowering ('knowledge is power'). These participants all had previous positive experience with using smartwatches. However, some participants were not interested in this data either because they had no present health issues and did not wish to worry about their health ('it is not something you can do anything about anyway') or

because of their general disinterest in the use of technology ('I am not a great one for data').

Older adults had varied technological ability with some using virtual reality and online shopping, whereas others had no WiFi or a sense there is 'too much' technology in daily life. Similarly, some participants expressed worry about who would access the data and felt being monitored closely would be intrusive, yet others felt comfortable with data, describing themselves as 'open minded' with 'nothing to hide.' Such perspectives were not associated with age of participants or severity of loneliness.

"I imagine one of your questions is going to be about the use of data and stuff like that. I'm very comfortable with that...I don't think Big Brother's going to have a huge interest in how many times my heart beats." (P1, Female, 68, Widowed, Moderate)

The main preference described by older adults was the need to be in control of both the data collected and alert sent by the system. It was important for older adults to understand which data was being collected and for what purpose. Older adults highlighted how it was important to be aware of the behaviours associated with loneliness and to know why they were being alerted.

"If the algorithms or whatever they call them, if it sees that predicted pattern and it happened once before it says, Oh, last time when you were in that- what actually brought those levels down was that you went and did this." (P35, Female, 68, Married, Moderate).

It was important for older adults to feel in control of data. Participants wished for any data or alerts to be sent to them directly and have the option of contacting other people if they deemed it necessary ('I'd much rather it came through me').

"The less control you have, the more control you need. So, people will control what they can control. And therefore, it's important that the end user has the control over how things are shared." (P52, Female, 66, Widowed, Not Lonely).

Theme 2: Perceived usefulness to address loneliness

Most participants described already being aware of their loneliness and did not see the benefit in being alerted about loneliness by the system ('I know I'm lonely I don't need an alert'). Linked with severity of loneliness, some older adults felt if you did not notice feelings of loneliness then a person was not truly feeling lonely.

"You're aware of the build up. If you aren't aware of it, then you're not of that degree of loneliness, you're just feeling low, can I put it that way? Whereas we can all feel low, and have a bad half hour, a bad day, but loneliness is something else that is different." (P40, Female, 75, Single, Moderate).

Nevertheless, some thought that the system would be a useful prompt as it provided 'concrete evidence' to the early warning signs of loneliness and would either 'consolidate' their recognition of

loneliness or motivate older adults to engage in behaviours to reduce loneliness. Older adults highlighted how it was important to be aware of the behaviours associated with loneliness and to know why they were being alerted. One participant compared the system to a ‘companion’ for people who felt alone, whereas others felt the system would have been useful in the past (e.g. during widowhood, retirement) or in the future (e.g. if cognitive ability reduced). Older adults who lived alone or had no family relayed a particular concern about falling in the home, and suggested the loneliness sensors could also be used to detect this.

Older adults questioned the use of the system if there was not a consequence or follow up to loneliness detection. Participants felt if they were to be alerted to loneliness there would also have to be a recommendation to reduce feelings of loneliness.

“If you could tell me how to reduce it, what to do, that would be more important than letting me or anybody else know that I was feeling- I know that I’m feeling it or about to feel it. But it’s what to do about it that’s the critical thing...There’s no point in it otherwise.” (P41, Female, 84, Divorced, Severe)

Theme 3: Personalisation as a priority

Sub-theme 3a: Level of loneliness

Older adults found it important to decide on a level of loneliness at which the alert would be sent to themselves. As participants had a variety of loneliness experiences this level would need to be tailored to individuals. For example, widowed older adults experienced transient loneliness (i.e. more severely at certain time) which may be time limited depending on individual grief trajectories. Older adults who lived on their own experienced chronic loneliness (i.e. at a low level constantly) and therefore questioned what changed the system could detect.

“You’ve got to decide on a level of stress that, you know, like we do on a scale of 1 to 10. You know, if I feel 3 amount of lonely, then don’t bother, it will probably pass over, but if I feel 7 or 8 amount of loneliness then please tell me to get off my bum and go out for a walk or something.” (P47, Female, 72, Widowed, Severe)

Participants varied in their responses describing how they would engage in activities to alleviate loneliness following an alert. Some participants described preferring to manage feelings of loneliness on their own especially for low levels of loneliness (‘if it’s only a bit lonely I can cope’). When discussing potential interventions following a loneliness alert participants highlighted the importance of personalisation as ‘every person is going to be different.’

Sub-theme 3b: Involvement of others

Participants also discussed the importance of personalisation in relation to the involvement of others, specifically healthcare professionals and family members. For example, some participants had

previously experienced suicidal thoughts during times of loneliness and felt it was important for healthcare professionals to be alerted if they experienced loneliness at that level in the future. However, many questioned whether busy healthcare professionals such as general practitioners (GPs) had the resources to help with loneliness.

“...the GP, he can’t give me a tablet to stop me being lonely or something like that. Can’t come round and spend time with me, you know. They haven’t got time to see you in the surgery. So, yes I mean I wouldn’t mind the GP knowing I was lonely. But I can’t see what advantage there would be there.” (P46, Female, 87, Widowed, Moderate).

Nevertheless, some felt the alert could be sent to healthcare professionals for severe loneliness or where loneliness was related to physical or mental health issues such as depression, and some mentioned signposting to counselling and social prescribing services.

Similarly, older adults felt that loneliness would have to be ‘severe enough’ for the system to contact family members and that this level of severity would differ between individuals.

“And you could choose the point at which it could be shared, if you like, with those people so that, yes, don’t bother to tell them if I’m feeling lonely 10% of the time, but maybe if I’m feeling lonely 50% of the time, then do. But it might be different for other people. (P52, Female, 66, Widowed, Not lonely)

When participants experienced mild feelings of loneliness, many did not want friends or family members sent the loneliness alert, stating they would feel ‘embarrassed’ or ‘guilty’, and that they could cope with it alone to avoid being a ‘burden’. Some participants expressed not having a problem with family receiving a loneliness alert however questioned what they would be able to do about it if they lived far away. In more severe cases of loneliness, participants thought the loneliness alert could be used as a ‘conversation starter’ during lonely periods where older adults felt less able to initiate social contact. However, others still felt the alert was ‘too private’ to share with others without prior consent from the older adults themselves. Vitally, other participants had no family so questioned who they could nominate to receive a loneliness alert.

“When you say you’d alert somebody, who would you alert in my case? I’ve got no one close that you could send an “I need help” message to.” (P43, Male, 70, Widowed, Moderate).

Overall, involvement of family, friends and healthcare professionals in a smart system to detect loneliness was thought to be part of a negotiation as to who the older adult would want involved, at what time, and for what purpose.

Discussion

Principal Results

We constructed three themes to represent what older adults considered important in a system able to detect loneliness. 'Interest and control of data' highlighted general interest in health data being a personal preference of older adults based on current or previous positive use of technologies. Participants had varying technological ability but were unanimous in their need to be in control of data collected and sent by the system. 'Perceived usefulness to address loneliness' refers to whether and how the system can be useful to older adults. Many older adults described being aware of feelings of loneliness, especially in severe cases, thus questioned the usefulness of the loneliness detection system. Participants emphasised the importance of providing recommendations to reduce loneliness following detection to improve usefulness. Finally, 'Personalisation as a priority' refers to the need to work with the individual using the system to determine the level of loneliness that results in an alert, and the consequences of that alert, including the involvement of others to support loneliness such as friends, family members or health and social care professionals.

The focus on control echoes concerns over privacy and data protection reported in previous studies on technology use in later life [22,48,49]. Loneliness has been associated with a lack of autonomy [50], and ageism can lead to feelings of powerlessness [23]. It is therefore vital that older adults feel in control of data collected and sent by a loneliness detection system. Trust in technologies can be established through providing feedback in real-time and through extensive validation [16,18]. Technology-based approaches for reducing social isolation may not be appropriate for all older adults [51]. As a 'digital divide' exists between those with cultural and financial access to technology and those who do not [19]. Research has found that lonelier older adults use information and communication technologies less often than their less lonely counterparts [52]. Factors which were found to influence engagement include lack of skills and support to use digital health technologies [53] and a fear or dislike of technology [21]. Ensuring older adults across a spectrum of ability to feel knowledgeable and confident with the data and associated alerts from the loneliness detection system are therefore paramount to its use.

The findings of this study suggest a key component of ensuring acceptability of a loneliness detection system is the effective implementation of personalisation. Our findings support previous literature which suggests that digital health systems should make it transparent as to who will gain access to the information collected, and ensure users retain control of who has access to it [54]. A novel finding from our work is the importance of determining an individually selected level of loneliness for which an alert would be sent, highlighting the subjective nature of loneliness [55]. Further consideration is required as to how degrees of loneliness would be measured and reported to the system, for example self-reporting from older adults or the use of validated loneliness scales [56].

More broadly, our findings on personalisation indicate the importance of ‘user-centred’ design in health technology - perspectives that centralise the needs of the user in the design and implementation of the technology [28,57,58].

In relation to the involvement of others in supporting loneliness once detected, older adults emphasised that whoever the system alerted, this should be decided in advance via a clear and transparent set of discussions. Participants tended to refer to GPs when health professionals were discussed, a finding that may mirror the trust instilled in doctors by older people [59,60]. Previous research on technology preferences of older adults has identified that if a device was recommended to older adults by a ‘credible’ health professional, it was more likely to be taken up and used [19]. The participants in the current study generally held negative attitudes to alerting family members of loneliness, mirroring concerns from previous research [61]. However, friends or family were not consulted in this study, therefore it is possible their thoughts of receiving an alert for loneliness may not align with those of older adults. Perceptions of burden were described as one reason for participant disapproval of family member involvement. Indeed, loneliness has often been linked with guilt, shame, and a perception that others do not care [3,62]. Further research is required on the involvement of family and/or friends in providing support following an alert from a loneliness detection system as many loneliness reduction interventions actively involve others [63].

Perceived usefulness is a core component of theoretical models of technology adoption in older adults [64,65]. Participants had varied perspectives on whether and how a loneliness detection system could be useful. Some saw it as potentially useful as a prompt to change their own actions or as an ‘early-warning’ sign before they would have thought to seek help, perhaps even before they realised they were lonely. Given the stigma of loneliness [3] and the reticence of older men to identify as lonely [62], such a system may be particularly useful for removing the anxiety and uncertainty of doing something about loneliness. Older adults in our study were clear that recommendations to reduce feelings of loneliness once detected were an imperative aspect of such a system. Research has highlighted how there is ‘no one size fits all’ approach to loneliness intervention and that tailored, targeted approaches are required to reduce loneliness (Victor et al., 2018). Detailed consideration is required on the selection of appropriate interventions for older adults using a loneliness detection system based on type of loneliness (i.e. emotional, social), severity of loneliness (i.e. moderate, severe, very severe), and reason for loneliness (i.e. bereavement, mobility issues). Future research will be required on the acceptability and effectiveness of such recommendations, noting that individual centred interventions are inherently limited by their lack of capacity to influence the social context of the lonely individual [3].

Limitations

This study adds to the emerging literature on sensor-based technologies to detect feelings of loneliness in older adults [17,28]. Despite efforts to achieve an equal distribution of gendered and cultural perspectives, our sample was majority female white-British. Our themes may therefore not represent the views of older adults with different perspectives on technologies which requires further consideration in future design testing. Our interview sample included people with lived experience of loneliness to provide relevant perspectives and expertise to inform future technology development [71]. It is important to acknowledge that such participants were more open to acknowledging and seeking help for loneliness than some of the prospective target population who may not readily seek help for loneliness. Thus, a gap exists in our knowledge from older adults with reduced help-seeking behaviour that may particularly benefit the use of a loneliness detection system. Finally, perspectives of participants were based on a conceptualised loneliness detection device described by the lead author conducting the interviews. There is no such actual device yet, therefore potential barriers and enablers identified in related research such as comfort, cost, and maintenance [72,73] could not be effectively discussed or reviewed. Interpretations of the loneliness detection system may vary amongst participants and further user-testing would be required to obtain information on acceptability once a device to detect physiological markers associated with loneliness has been developed [33].

Conclusion

Findings from this in-depth qualitative study provide important perspectives from people with lived-experience of loneliness on the context in which a sensor-based loneliness detection system would be most useful and acceptable to older adults. It is important to support older adults across a spectrum of abilities and preferences to feel knowledgeable and confident with technologies used by a future loneliness detection system. For older adults to feel in control, transparency on data collected by the system is required in addition to options for personalisation related to levels of loneliness which creates an alert, and which supporters are informed. This should be identified through a clear and full discussion, before they commence using it, of when, why, and who the device should alert in the event of it detecting loneliness. Perceived usefulness of a future loneliness detection system is reliant on activities to reduce feelings of loneliness being recommended following identification of loneliness. Future research will include such perspectives in the design of innovative technologies enabling the early detection of loneliness and access to timely interventions to tackle loneliness in later life.

References

1. Cacioppo JT, Cacioppo S. The growing problem of loneliness. *The Lancet* 2018;**391**:426.

2. Perlman D, Peplau LA. Toward a Social Psychology of Loneliness. 1981.
3. Barreto M, Doyle DM, Qualter P. Changing the narrative: Loneliness as a social justice issue. *Polit Psychol* 2024;**45**:157–81.
4. Cacioppo JT, Cacioppo S. Loneliness in the Modern Age: An Evolutionary Theory of Loneliness (ETL). *Advances in Experimental Social Psychology*. Vol 58. Academic Press Inc., 2018, 127–97.
5. Schinka KC, Vandulmen MHM, Bossarte R *et al*. Association Between Loneliness and Suicidality During Middle Childhood and Adolescence: Longitudinal Effects and the Role of Demographic Characteristics. *J Psychol* 2012;**146**:105–18.
6. Lam JA, Murray ER, Yu KE *et al*. Neurobiology of loneliness: a systematic review. *Neuropsychopharmacology* 2021, DOI: 10.1038/s41386-021-01058-7.
7. Victor CR, Bowling A. A longitudinal analysis of loneliness among older people in Great Britain. *J Psychol* 2012;**146**:313–31.
8. Victor CR, Yang K. The Prevalence of Loneliness Among Adults: A Case Study of the United Kingdom. *J Psychol* 2012;**146**:85–104.
9. Pikhartova J, Bowling A, Victor C. Is loneliness in later life a self-fulfilling prophecy? *Aging Ment Health* 2016;**20**:543–9.
10. Chawla K, Kunonga TP, Stow D *et al*. Prevalence of loneliness amongst older people in high-income countries: A systematic review and meta-analysis. *PLoS One* 2021;**16**:e0255088.
11. Tjihuis MAR, De Jong-Gierveld J, Feskens EJM *et al*. Changes in and factors related to loneliness in older men. The Zutphen Elderly Study. *Age Ageing* 1999;**28**:491–5.
12. Alpass FM, Neville S. Loneliness, health and depression in older males. *Aging Ment Health* 2003;**7**:212–6.
13. Barjaková M, Garner A. *Risk Factors for Loneliness A Literature Review.*, 2022.
14. Cohen-Mansfield J, Hazan H, Lerman Y *et al*. Correlates and predictors of loneliness in older-adults: a review of quantitative results informed by qualitative insights. *Int Psychogeriatr* 2016;**28**:557–76.
15. Davies AR, Honeyman M, Gann B. Addressing the Digital Inverse Care Law in the Time of COVID-19: Potential for Digital Technology to Exacerbate or Mitigate Health Inequalities. *J Med Internet Res* 2021;**23**, DOI: 10.2196/21726.
16. Morgavi G. A Virtual Village Network Architecture for improving the elderly people quality of life. *Inteligencia Artificial* 2015;**18**:26–34.
17. Site A, Lohan ES, Jolanki O *et al*. Managing Perceived Loneliness and Social-Isolation Levels for Older Adults: A Survey with Focus on Wearables-Based Solutions. *Sensors (Basel)* 2022;**22**, DOI: 10.3390/S22031108.
18. Qirtas MM, Zafeiridi E, Pesch D *et al*. Loneliness and Social Isolation Detection Using Passive Sensing Techniques: Scoping Review. *JMIR Mhealth Uhealth* 2022;**10**, DOI: 10.2196/34638.
19. LaMonica HM, Davenport TA, Roberts AE *et al*. Understanding Technology Preferences and Requirements for Health Information Technologies Designed to Improve and Maintain the Mental Health and Well-Being of Older Adults: Participatory Design Study. *JMIR Aging* 2021;**4**:e21461.
20. Wrede C, Braakman-Jansen A, van Gemert-Pijnen L. Understanding acceptance of contactless monitoring technology in home-based dementia care: a cross-sectional survey study among informal caregivers. *Front Digit Health* 2023;**5**:1257009.
21. Wilson J, Heinsch M, Betts D *et al*. Barriers and facilitators to the use of e-health by older adults: a scoping review. *BMC Public Health* 2021;**21**:1–12.
22. Naveira AV, De Masi A, Wac K *et al*. Designing a Social Robot Companion to Support Homecare: Usability Results. *Stud Health Technol Inform* 2022;**295**:261–4.
23. Walsh K, Scharf T, Keating N. Social exclusion of older persons: a scoping review and conceptual framework. *Eur J Ageing* 2017;**14**:81–98.
24. Kantar Public. *Trapped in a Bubble : An Investigation into Triggers for Loneliness in the UK*. Co-operative/British Red Cross : Kantar Public=, 2016.

25. Latikka R, Rubio-Hernández R, Lohan ES *et al.* Older Adults' Loneliness, Social Isolation, and Physical Information and Communication Technology in the Era of Ambient Assisted Living: A Systematic Literature Review. *J Med Internet Res* 2021;23(12):e28022 <https://www.jmir.org/2021/12/e28022> 2021;23:e28022.
26. Doryab A, Villalba DK, Chikersal P *et al.* Identifying Behavioral Phenotypes of Loneliness and Social Isolation with Passive Sensing: Statistical Analysis, Data Mining and Machine Learning of Smartphone and Fitbit Data. *JMIR Mhealth Uhealth* 2019;7(7):e13209 <https://mhealth.jmir.org/2019/7/e13209> 2019;7:e13209.
27. Cacioppo JT, Ernst JM, Burleson MH *et al.* Lonely traits and concomitant physiological processes: the MacArthur social neuroscience studies. *International Journal of Psychophysiology* 2000;35:143–54.
28. Prabhu D, Kholghi M, Sandhu M *et al.* Sensor-Based Assessment of Social Isolation and Loneliness in Older Adults: A Survey. *Sensors (Basel)* 2022;22, DOI: 10.3390/S22249944.
29. Domínguez-Jiménez JA, Campo-Landines KC, Martínez-Santos JC *et al.* A machine learning model for emotion recognition from physiological signals. *Biomed Signal Process Control* 2020;55:101646.
30. Fan T, Qiu S, Wang Z *et al.* A new deep convolutional neural network incorporating attentional mechanisms for ECG emotion recognition. *Comput Biol Med* 2023;159:106938.
31. Gu Y, Zhong X, Qu C *et al.* A Domain Generative Graph Network for EEG-Based Emotion Recognition. *IEEE J Biomed Health Inform* 2023;27:2377–86.
32. Rees J, Matcham F, Probst F *et al.* Wearables, sensors and the future of technology to detect and infer loneliness in older adults. *Gerontechnology* 2023;22:1–4.
33. Rees J, Liu W, Canson J *et al.* Qualitative exploration of the lived experiences of loneliness in later life to inform technology development. *Int J Qual Stud Health Well-being* 2024;19:2398259.
34. Venkatesh V, Morris MG, Davis GB *et al.* User acceptance of information technology: Toward a unified view. *MIS Q* 2003;27:425–78.
35. Barreto M, van Breen J, Victor C *et al.* Exploring the nature and variation of the stigma associated with loneliness. *J Soc Pers Relat* 2022;39:2658–79.
36. Austin J, Dodge HH, Riley T *et al.* A Smart-Home System to Unobtrusively and Continuously Assess Loneliness in Older Adults. *Point of care technologies* 2016;4, DOI: 10.1109/JTEHM.2016.2579638.
37. Ratcliffe J, Galdas P, Kanaan M. Older men and loneliness: a cross-sectional study of sex differences in the English Longitudinal Study of Ageing. *BMC Public Health* 2024;24:1–16.
38. GOV.UK. *Loneliness Interventions across the Life-Course.*, 2023.
39. Paquet C, Whitehead J, Shah R *et al.* Social Prescription Interventions Addressing Social Isolation and Loneliness in Older Adults: Meta-Review Integrating On-the-Ground Resources. *J Med Internet Res* 2023;25, DOI: 10.2196/40213.
40. Probst F, Rees J, Aslam Z *et al.* Evaluating a Smart Textile Loneliness Monitoring System for Older People: Co-Design and Qualitative Focus Group Study. *JMIR Aging* 2024;7:e57622.
41. Rees J, Liu W, Ourselin S *et al.* Understanding the psychological experiences of loneliness in later life: qualitative protocol to inform technology development. *BMJ Open* 2023;13:e072420.
42. De Jong Gierveld J, Tilburg TV. The De Jong Gierveld short scales for emotional and social loneliness: tested on data from 7 countries in the UN generations and gender surveys. *Eur J Ageing* 2010:121–30.
43. Russell DW. UCLA Loneliness Scale (Version 3): Reliability, Validity, and Factor Structure. *J Pers Assess* 1996;66:20–40.
44. Braun V, Clarke V. Reflecting on reflexive thematic analysis. *Qual Res Sport Exerc Health* 2019;11:589–97.
45. Javadi M, Zarea K. Understanding Thematic Analysis and its Pitfall. *Journal of Client Care* 2016;1, DOI: 10.15412/j.jcc.02010107.

46. Braun V, Clarke V. Using thematic analysis in psychology. *Qual Res Psychol* 2006;**3**:77–101.
47. Pawson R, Tilley N. *Realist Evaluation*. Sage (ed.), 1997.
48. Davis K, Owusu EB, Marcenaro L *et al*. Pervasive sensing for social connectedness. *Enhanced Living Environments: From Models to Technologies*. Institution of Engineering and Technology, 2017, 49–79.
49. Wrede C, Braakman-Jansen A, Van Gemert-Pijnen L. Requirements for Unobtrusive Monitoring to Support Home-Based Dementia Care: Qualitative Study Among Formal and Informal Caregivers. *JMIR Aging* 2021;**4**(2):e26875 <https://aging.jmir.org/2021/2/e26875> 2021;**4**:e26875.
50. Henning G, Segel-Karpas D, Bjälkebring P *et al*. Autonomy and loneliness – longitudinal within- and between-person associations among Swedish older adults. *Aging Ment Health* 2022;**26**:2416–23.
51. Chen YRR, Schulz PJ. The effect of information communication technology interventions on reducing social isolation in the elderly: A systematic review. *J Med Internet Res* 2016;**18**:e4596.
52. Talmage CA, Knopf RC, Wu T *et al*. Decreasing Loneliness and Social Disconnectedness among Community-Dwelling Older Adults: The Potential of Information and Communication Technologies and Ride-Hailing Services. <https://doi.org/10.1080/0192478820201724584> 2020;**45**:89–117.
53. Chadwick H, Lavery L, Finnigan R *et al*. Engagement With Digital Health Technologies Among Older People Living in Socially Deprived Areas: Qualitative Study of Influencing Factors. *JMIR Form Res* 2024;**8**:e60483.
54. Alaoui M, Lewkowicz M. Practical issues related to the implication of elderlies in the design process – The case of a Living Lab approach for designing and evaluating social TV services. *IRBM* 2015;**36**:259–65.
55. Mansfield L, Victor C, Meads C *et al*. A conceptual review of loneliness in adults: Qualitative evidence synthesis. *Int J Environ Res Public Health* 2021;**18**, DOI: 10.3390/ijerph182111522.
56. Campaign to end loneliness. Measuring your impact on loneliness in later life. 2015.
57. Harte RP, Glynn LG, Broderick BJ *et al*. Human Centred Design Considerations for Connected Health Devices for the Older Adult. *Journal of Personalized Medicine* 2014, Vol 4, Pages 245-281 2014;**4**:245–81.
58. Probst F, Ratcliffe J, Molteni E *et al*. A scoping review on human-centered design approaches and considerations in the design of technologies for loneliness and social isolation in older adults. *Design Science* 2024;**10**:e39.
59. Appleby J, Robertson R. Public satisfaction with the NHS in 2015 Results and trends from the British Social Attitudes survey. 2016.
60. Butterworth JE, Campbell JL. Older patients and their GPs: shared decision making in enhancing trust. *The British Journal of General Practice* 2014;**64**:e709.
61. Neves BB, Franz RL, Munteanu C *et al*. Adoption and feasibility of a communication app to enhance social connectedness amongst frail institutionalized oldest old: an embedded case study. *Inf Commun Soc* 2018;**21**:1681–99.
62. Ratcliffe J, Wigfield A, Alden S. ‘A lonely old man’: empirical investigations of older men and loneliness, and the ramifications for policy and practice. *Ageing Soc* 2021;**41**:794–814.
63. Gardiner C, Geldenhuys G, Gott M. Interventions to reduce social isolation and loneliness among older people: an integrative review. *Health Soc Care Community* 2018;**26**:147–57.
64. Schroeder T, Dodds L, Georgiou A *et al*. Older Adults and New Technology: Mapping Review of the Factors Associated With Older Adults’ Intention to Adopt Digital Technologies. *JMIR Aging* 2023;**6**, DOI: 10.2196/44564.
65. Davis FD. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Q* 1989;**13**:319–39.
66. Victor C, Mansfield L, Kay T *et al*. *An Overview of Reviews: The Effectiveness of Interventions to Address Loneliness at All Stages of the Life Course*. What Works Centre for Wellbeing, 2018.
67. What Works Wellbeing. *What Do We Know about Tackling Loneliness?*, 2018.
68. Lasgaard M, Løvschall C, Qualter P *et al*. Are loneliness interventions effective in reducing

loneliness? A meta-analytic review of 128 studies: Mathias Lasgaard. *The European Journal of Public Health* 2022;**32**, DOI: 10.1093/EURPUB/CKAC129.266.

69. Shah SGS, Nogueras D, van Woerden HC *et al*. Evaluation of the effectiveness of digital technology interventions to reduce loneliness in older adults: Systematic review and meta-analysis. *J Med Internet Res* 2021;**23**:e24712.

70. Beckers A, Buecker S, Casabianca EJ *et al*. *Effectiveness of Interventions Tackling Loneliness: A Literature Review.*, 2022.

71. Muchamore I, Karanikolas P, Gooding PM. *How Lived Experience Expertise Shapes Research and Development in Digital Mental Health: A Review of the Literature and Insights*. Elsevier BV, 2024.

72. Ambagtsheer RC, Borg K, Townsin L *et al*. The effectiveness of technology interventions in reducing social isolation and loneliness among community-dwelling older people: A mixed methods systematic review. *Archives of Gerontology and Geriatrics Plus* 2024;**1**:100008.

73. Corbett CF, Wright PJ, Jones K *et al*. Voice-Activated Virtual Home Assistant Use and Social Isolation and Loneliness Among Older Adults: Mini Review. *Front Public Health* 2021;**9**:742012.