The Effectiveness and Usability of Companion Robots in Combating Loneliness in the Elderly in Mental Healthcare: A Scoping Literature Review

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Abstract

Background. With the population exponentially growing and the elderly population experiencing increasing loneliness, there remains a growing health care issue that is overlooked. As a response, there have been increasingly new developments in the realm of technology to help counteract the growing issue of loneliness in the elderly; this is achieved with the use of psychological intervention with the implementation of so-called companion robots.

Objective This scoping review aims to systematically show what is known about companion robots used to reduce loneliness in the elderly, focusing on the effectiveness and the acceptance and attitudes that influence the older adults' use of such companion robots.

Method A literature search was performed in PsycINFO and Scopus using a combination of search terms regarding terms such as companion robots, loneliness and the elderly. Both the Unified Theory of Acceptance and Use of Technology (UTAUT) and a Quality Assessment designed by Ter Stal (2021) were performed.

Results A final set of 12 articles were included in the scoping review. All studies included were labelled as low quality within the quality assessment as they included less than 50 participants. Nine of the included studies found that loneliness in the elderly decreased or that social connectedness increased with the use of the companion robot. Overall, there were more positive aspects reported in regards to the acceptance and use of companion robots than negative aspects. Some of the positive aspects being the offered companionship and its ability to enhance the relationships amongst the older adults. A weakness was what some described as not seeing themselves as the suitable target group for such an intervention.

Conclusion. This review provided insights into the effectiveness of companion robots in reducing loneliness in the elderly as well as insights into the acceptance of such technologies. Further research is needed regarding interventions using companion robots on a larger scale as well as further research being needed in regards to the acceptance and use of this technology by the elderly.

Keywords: Companion robots, Loneliness, Covid-19 Pandemic, Elderly, Mental Healthcare, Literature review, Technology, EHealth, Artificial Agents.

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Introduction

The population is expanding at an exponential rate and people are becoming older. The elderly population has remained under the radar until recently when due to the covid-19 pandemic isolation and loneliness amongst all ages became increasingly apparent (World Health Organization, 2021). For many years, elderly populations have become increasingly isolated and lonely, sparking growing interest over the years in finding possibilities to decrease this growing concern (Crewdson, 2016; Kasar & Karaman, 2021; Patel & Clark-Ginsberg, 2020). Countries such as the UK and Japan have even appointed a "loneliness minister" within their government to try to find possibilities and strategies for decreasing this serious threat to the health of the elderly population (World Health Organization, 2021).

Loneliness in the Elderly

Everyone may at some point experience some form of loneliness, however, when it becomes excessive or chronic, that is when it becomes a health concern and causes long-term interpersonal issues (Shiovitz-Ezra & Ayalon, 2009). Loneliness is the feeling that an individual can get even in the presence of others and is extremely subjective (Kasar & Karaman, 2021). Loneliness is defined as a subjective feeling that one's personal and social needs are not being addressed and can be experienced as painful (Wister et al., 2021). Certain risk factors make individuals more susceptible to experiencing moderate or severe loneliness; these include gender, age, level of education, medical status (e.g. cancer, diabetes, or stroke), and functional impairment (e.g. dementia) (Shiovitz-Ezra & Ayalon, 2009). Shiovitz-Ezra & Valon (2009) found that there were significant differences across groups, with females for example being more likely to be classified as situationally/ chronically lonely. Additionally, individuals categorised as chronically lonely were found to have increased functional impairment, increased medical conditions, were less educated and were more likely to suffer from depression (Shiovitz-Ezra & Ayalon, 2009).

Loneliness is not only associated with less happiness and overall life satisfaction but also includes psychological and physical deficiencies that occur due to increased loneliness, including depression, headaches, and difficulty sleeping (Golden et al., 2009). This health issue has been a growing concern for many years, however with the past two years and the occurrence of Covid-19 causing a global pandemic, loneliness also due to isolation has skyrocketed in both the elderly and the general population (Patel & Clark-Ginsberg, 2020). Loneliness is a substantial risk factor in the elderly population for a range of health disorders, including stroke and coronary heart disease, and is linked to a 26 to 50 percent greater risk of

death (Kasar & Karaman, 2021). One research investigation found that 61% of older people living in care homes were moderately lonely and that 35% were severely lonely (Gardiner et al., 2020). Additionally, an eight-year longitudinal study found that 30% of the elderly in the UK suffered from some form of loneliness and that 9 % of the elderly population in the UK suffered from severe loneliness (Crewdson, 2016). Loneliness and/or social isolation will affect one-third to one-quarter of elderly adults, with around 10% experiencing chronic levels of such an illness (Wister et al., 2021). Recent studies have shown that there is a significant increase in loneliness in elderly people due to the covid-19 pandemic (Kasar & Karaman, 2021). Because of this extreme increase, it is necessary to find a way to counteract loneliness in the elderly in order to preserve their well-being and decrease any negative side effects of loneliness.

Technology to Diminish Loneliness

Research has been investigating how loneliness can be diminished to improve elderly living. A newer idea that has become more popular over the years with technological developments in the use of technology is eHealth, which includes the use of communication technology, videoconference technology, video gaming, and robotics (Wister et al., 2021). Technology is predicted to play a crucial role in assisting community-dwelling older individuals to maintain healthy levels of social engagement by serving as a substitute for or supplement to face-to-face social interaction (Wister et al., 2021). Research has demonstrated that technology is able to have a decreasing effect on the feeling of loneliness in people and as a result decreases the repercussions of loneliness (Goel & Sahai, 2021). Goel and Sahai (2021) mention that some forms of technology available in the aid of easing loneliness in people are online entertainment, online counselling, online platforms, or virtual interactions through video conferencing. These technologies allow for a decrease in loneliness and therefore a decreasing effect in the accompanying negative consequences of loneliness (Goel & Sahai, 2021). It has therefore been shown that technology can affect the feelings and behaviour of an individual allowing for an increase in positive and a decrease in negative emotions.

Companion Robots to Combat Loneliness

EHealth offers many different technologies of which there have been studies and investigations. A form of technology known to decrease loneliness is artificial agents (Robinson et al., 2013). Using artificial agents benefits individuals by accounting for staff shortages and time constraints whilst receiving a variety of care that otherwise may not be

accessible or possible (i.e. animal or social connections), as well as it being an efficient way of getting actionable data for researchers. The two most well-known examples of artificial agents, are the companion robots known as PARO (a white fluffy seal robot) and AIBO (a metallic doglike robot) (Robinson et al., 2013). PARO is a fluffy white seal that was designed to resemble real-life animal therapy, which has proven to be helpful in increasing well-being and decreasing loneliness (Hung et al., 2019; Robinson et al., 2013). AIBO is a robotic dog designed to imitate live animals, which were found to increase social interaction and decrease loneliness (Kramer et al., 2015). Research has found that a promising use of companion robots is in the way they are implemented to counteract the results of loneliness, which was increased by the Covid-19 pandemic (Ghafurian et al., 2021). A companion robot is an artificial intelligence agent, i.e., a robot that can make itself useful, by offering a range of activities, such as interactive games, the playing of music and news and reactive noises and movements in reaction to contact with the individual, to aid humans such as the elderly in their home environment. Additionally, a companion robot behaves in a social manner by possessing certain social skills in acting out certain mannerisms to engage with individuals (Dautenhahn, 2007).

Social and companion robots have been found to have a promising function as companions in minimising loneliness and social isolation. They have proven to be effective in assisting and providing care in a variety of settings, including lowering depression, enhancing the mood of the elderly, and even reducing the necessity of the use of medication (Ghafurian et al., 2021). Additional positive effects have been found in the increase in well-being, the reduction of stress hormones, and the improvement of brain functioning (Schröder et al., 2020; Robinson et al., 2014; Robinson et al., 2013). In diminishing loneliness with the use of companion robots, it is possible to prevent the development of negative consequences and improve older adults´ overall mental well-being. However, research on companion robots remains scarce especially regarding the topic of decreasing loneliness. There is an increase in research necessary for the prospect of being able to implement companion robots to decrease loneliness. As research remains insufficient, the full capacity of robots has not yet been reached. The necessity to adapt and the need for multiple abilities remains constant, they are therefore consistently being monitored, trialled and improved. As a possible means of studying the effects that underlie the acceptance and use of technology is the use of the Unified Theory of Acceptance and Use of Technology (UTAUT) model. In order to obtain insight and knowledge to understand to what extent people consider changing and therefore

whether they are open to change depends on their acceptance of certain technologies (Ghafurian et al., 2021).

Acceptance of Companion Robots

In order for companion robots to be successful in their essence and in their task to diminish loneliness in the elderly, it is essential that the older adults accept the companion robots. It is relatively simple; if older adults do not accept the companion robots or the idea of them, then they will not use them. Research found that during the period of 2012 to 2017 people's opinions of robots were very negative and they were therefore more cautious towards the use of such technology (Ghafurian et al., 2021). Acceptance of technology is determined by the degree to which the individual's attitudinal perception and their behavioural intentions to use the technology evolve. This attitude toward acceptance is part of a larger concept in understanding the preferences and commitment toward technology-assisted interventions (Ke, 2020). Designers and developers need to keep in mind the user they are creating the robot for, and then need to consider whether an elderly individual would accept the robot and whether they would then use it (Robinson et al., 2014). Ultimately, robots can only be successful if they are accepted by their target users (Bzura et al., 2012). However, their acceptance is built based on their attitude toward the technology and use thereof in elderly care.

Attitudes and Perceptions

For acceptance to increase, individual's attitudes and perceptions towards companion robots must be open and interested. Society needs to have a positive attitude toward the use of companion robots in order for success to become apparent in diminishing loneliness (Ghafurian et al., 2021). Scopelliti et al., (2004) found that older adults' feelings toward having a robot in the home were more negative even at the point of feeling frightened about the prospect. This feeling may have developed due to the fact that the majority of humans have no direct contact with robots (Broadbent et al., 2010). As a result of having no first-hand experience with robots, people's perceptions of them are shaped by their exposure within the entertainment industry, in media, or in literature (Broadbent et al., 2010; Dautenhahn et al., 2005). The little interaction that is then held via distance through media etc. is still able to allow individuals to make a mental representation about the technology of robots (Broadbent, 2010). In 2005 the article by Dautenhahn et al., (2005) found that 40% of elderly participants were in favour of the idea of having a robot companion within their home, however, this result was a lot less than the 80% who had stated they enjoyed having a form of computer technology in their home. Few subjects were completely against the idea of the use of a

companion robot and were found to enjoy interactions with a robot in trial sessions (Dautenhahn et al., 2005). This research however stems from 2005; up-to-date research remains minimal, leaving a gap in knowledge regarding the elderly perceptions and acceptance of the use of such a technology. The factors influencing older adults in their use of the technology, more specifically companion robots, lie not only in their acceptance of the technology as well as their underlying attitudes and perceptions but also in their perceived usefulness and perceived ease of use, similar to what the UTAUT model investigates (Heerink et al., 2008). This research is therefore investigating not only the perceived use of companion robots in diminishing loneliness in older adults but also investigating their acceptance of such a technology.

UTAUT

Behind the elderly population's acceptance to use the technology lies many factors that influence them. The UTAUT integrates eight influential acceptance models that not only investigate the perceived usefulness and the perceived ease of use of the technology as used in the Technology Acceptance Model (TAM) but also include other characteristics (Nordhoff et al., 2020; Straub, 2009). These characteristics include age, experience, and social influence that affect people's behaviour and attitude intention, ultimately affecting their use of technology (Nordhoff et al., 2020; Straub, 2009). The UTAUT identified four key factors influencing the acceptance and use of technology as effort expectancy (i.e., the ease of use), social influence, performance expectancy (i.e., the usefulness of the technology), and the facilitation of conditions (Ke et al., 2020). Specifically the UTAUT aims at investigating acceptance of technology with acceptance being extremely important for the incorporation of companion robots into older adult's daily activities and lives as mentioned previously.

The Objective of this Scoping Literature Review

The objective of this scoping literature review is to evaluate to what extent companion robots are able to diminish loneliness in the elderly. Additionally, this research will focus on identifying whether interventions using companion robots to diminish loneliness in the elderly are being used effectively by investigating the positive and negative effects of these interventions. To increase the visibility and availability of needed information, this review will also focus on identifying the factors that influence older adults in their use of companion robots that specifically intend on combating loneliness in the elderly. Current literature has begun investigating these phenomenons however information is scattered, because of this, the review is done in order to bring information together and add important information to the

availability of research that is growing on this topic. This scoping literature review aims at answering the following questions:

1. To what extent are Companion Robots able to diminish Loneliness in the Elderly?
    a. Are interventions using companion robots effectively in diminishing loneliness in the elderly?
    b. What factors influence older adults' use of companion robots?

Methods

To best present the current wide variety of research and study content available on the elderly and the use of social companion robots to decrease their loneliness, a scoping review is most appropriate. In the use of a scoping review, a broader search and extended answers are given whilst remaining systematic (Arksey & O´Malley, 2005). This scoping review was conducted with the use of the foundation and principles designed by Arksey and O´Malley (2005). The framework of Arksey and O´Malley is made up of five stages: Stage1: Identifying the research question; Stage 2: Identifying relevant studies; Stage 3: Study selection; Stage 4: Charting the data; Stage 5: Collating, summarising, and reporting the results.

Identification of the Research Question

An initial search of the literature indicated that the growing issue of loneliness in the elderly population has already gained the attention of researchers. It is being investigated to what extent loneliness could be diminished by numerous different interventions including the use of technology, more specifically the use of companion robots. This scoping literature review aims at being an addition to the available research in giving further insight into the effectiveness of companion robots in diminishing loneliness as well as the factors that influence older adults use of such technology.

Identifying Relevant Studies

The following bibliographical databases were searched: Scopus and PsycINFO. To identify all potential literature, including that which may not have been found in the database searches, the references list of each article was also included and reviewed (i.e. the snowball method).

Keywords for the population of this research included:

(lonel* OR loneliness OR lonely OR isolated OR “social isolation”)

AND

("older adult*" OR "older people" OR elder* OR senior* OR aged)

AND

("robot" OR "companion robot" OR "companion agent" OR "conversational agent" OR "communicative agent" OR "social robot" OR "conversational agent")

Each group of keywords was separated by the Boolean operator "AND" and all the above-mentioned keywords were separated by the operator "OR" in order to allow for qualitative and quantitative reflection of available research.

Table 1.

Examples of Search Terms Used to Locate Literature Within Two Databases.

Date of search	Database	Language	Search in	Document type
	Scopus	English	Article title-Abstract-Keywords	Articles, conference papers
	PsycINFO	English	Article title-Abstract-Keywords	All journals

Study Selection

The screening process began with the identification of inclusion criteria. A total of four inclusion criteria were determined. The inclusion criteria i.e., the relevance of a study was determined by the inclusion of the following criteria: the article had to be of scientific origin (i.e., a journal article or conference paper) and the language of publication needed to be English. The population of the selected studies had to be about or include the "elderly" defined as an individual above the age of 65 years (Orimo et al., 2006). Finally, the intervention mentioned needed to be in some form about the use of a robot as an intervention (i.e., eHealth: social robot; companion robot) in order to diminish or decrease the explored outcome of loneliness. All research taken into consideration must have been published no later than 2005 to remain as relevant and time reflective as possible. Articles that did not meet the above-mentioned inclusion criteria were excluded. The screening process was then continued by assessing relevant titles available through the databases (Scopus & PsycINFO). Duplicates were removed by using EndNote X9. The articles were then further screened, wherein their title and abstract were reviewed. Finally, the full-text articles were examined to determine their relevance.

Charting the Data

An Excel sheet is used to chart the gathered information. The data that was collected included the author's names, the age and gender of participants, the sample size, and the year of publication. Additionally, descriptive data extracted from the articles also included the location of the intervention, and the study design. As part of the data extraction, the focus was also placed on finding information on the effectiveness and factors influencing the usage of companion robots. Regarding the effectiveness, positive and negative emotions of participants was investigated. Finally, the main findings, results and the outcome technique of the artificial agent used were also included within the data extraction.

Collating, Summarising, and Reporting the Results

The charting sheets' results were summarised and displayed in tables. The research topic's emphasis was evaluated in-depth, as were the effectiveness in reducing loneliness and the factors that influence the use. The context of the research, the intervention used, and the quality of the research were also retrieved.

Quality Assessment

A quality assessment was conducted by adding a label attached to each publication. The labels were given based on the dissertation by Ter Stal (2021) and the article "A renewed framework for the evaluation of telemedicine" by Kosterink et al., (2016). Additionally, the number of research participants and the article's evaluation stage were used to give labels.

1. Stage 1. - Low (technical efficacy): the focus is on the feasibility and usability of the technology, and less than 50 participants.
2. Stage 2. - Fair (technical efficacy): the focus is on the feasibility and usability of the technology, and more than 50 participants.
3. Stage 3. - Moderate (specific system objectives): able to gain an initial idea about the potential added value for clinical practice and possible working mechanism.
4. Stage 4. - Good (system analysis): technology is evaluated in the way it will be implemented in daily clinical practice.
5. Stage 5. - Excellent (external Validity): elaboration of the adoption is addressed as in stage 3.

Results

From the 693 articles that were identified by the database searches of Scopus and PsycINFO, after inclusion and exclusion criteria, nine articles were included in the review. In addition, three articles were included using the snowballing method resulting in 12 articles being included in the final review. Figure 1 shows the flow diagram of the databases searched and their article screenings as well as the snowball method implemented.

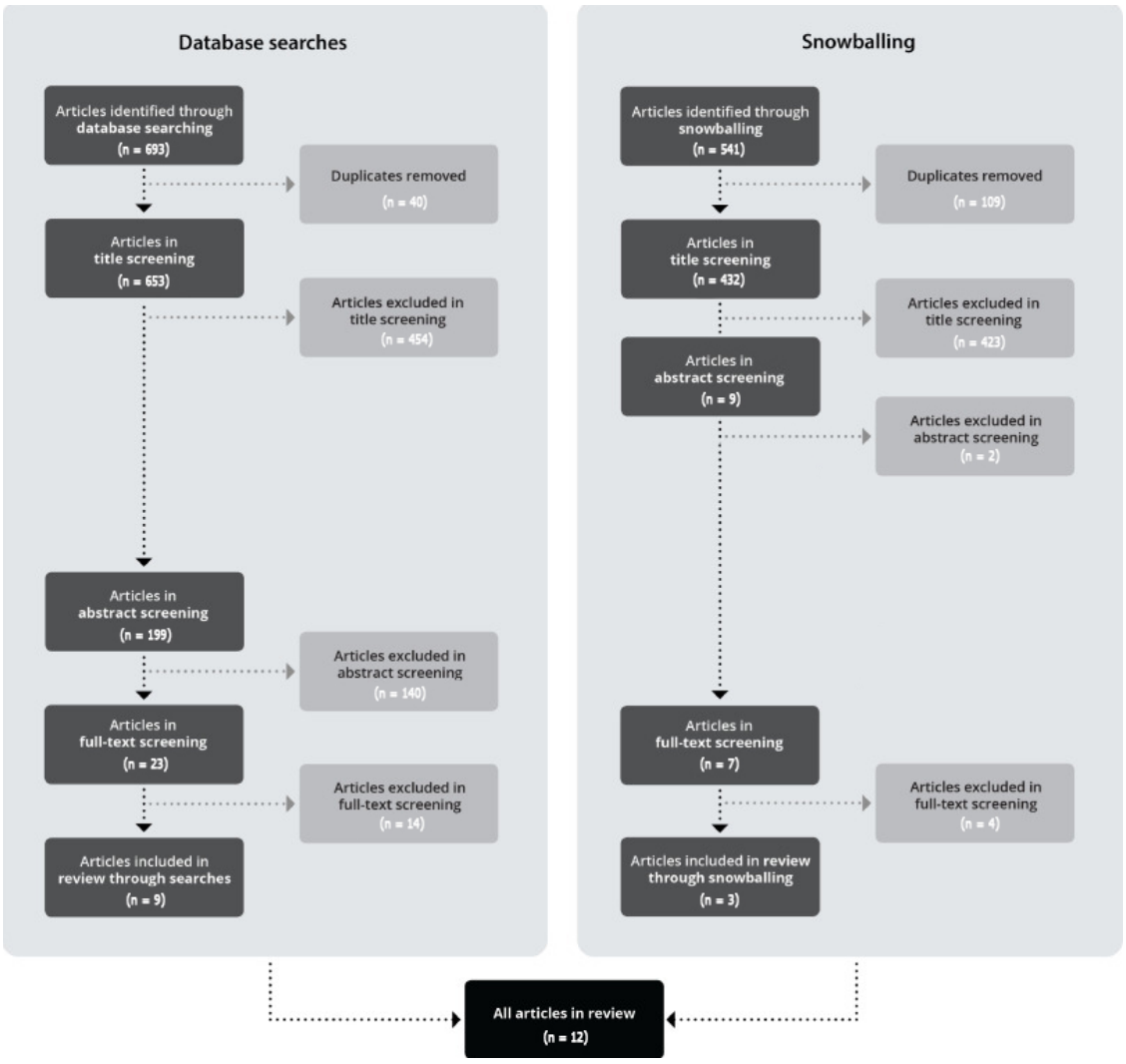

Fig.1. Flow diagram of the database searches and article screenings.

Characteristics of the Included Studies

Table 2 lists general information about the articles included in the review. The included studies were published between 2008 and 2022.

Table 2.

General Information of the Articles Included

Article, Year	Sample Mean Age, Sample Gender	Sample Size	Study Design, Duration	Measure	Results	Technique
Banks et al., 2008	n/s	38	Experiment (RCT): control (no animal assisted therapy) and real dog comparator 8 weeks	UCLA; modified MLAPS	Significantly less loneliness, the loneliest improved most.	Direct companion
Barrett et al., 2019	83 f: 7; m: 3	10	Experiment; single group, pre-post 4 weeks	Bespoke questionnaire & Observations	Social connectedness increased through frequent engagement.	Catalyst for social interaction
Casey et al., 2020	n/s	38 Patients 107 Stakeholders	Over 12 months	Reflective Interviews	Mario accepted as social care for dementia	Direct companion; Catalyst for social interaction.
Chen et al., 2020	81.1 (65–93) f:13; m:7	20	Experiment/ Mixed methods; control: no robot 16 weeks	Interviews; version 3 (20-item) UCLA; WHO-QOL-OLD (World Health	Significant positive change in loneliness	Direct companion; Intended use: Social interaction

				Organisation Quality of Life Questionnaire).		
Chen et al., 2022	82.6 (68-91) f:16; m:9	25	Semi structured qualitative Interviews; Thematic Analysis; Robot interaction for 8 weeks.	Geriatric Depression Scale-Short Form (GDS-SF), Mini-Mental State Examination (MMSE); Interviews	Paro provides companionship, improve interpersonal relationships, combat loneliness and increase levels of engagement	Direct companion
D´Onofrio et al., 2019	77.08 (55–93) f:24; m:14	38	Observational; quantitative; pre-test, post-test	Mini-Mental State Examination (MMSE); Observations	-	Direct companion.
Fogelson et al., 2021	89.6 f:16; m:2	18	Mixed research design with pre- and post-questionnaires on depression and loneliness	Global Deterioration Scale (GDS); The UCLA Loneliness Scale (Version 3); GDS-15	Depression and loneliness improved. Participants more engaged, provides positive experiences.	Direct companion.

Hudson et al., 2020	76 (65–90) f:10; m:10	20	Observational; qualitative; longitudinal 4 weeks	Interviews	More engagement, increased companionship forge connections, strong attachment, decrease loneliness	Direct companion.
Liang et al., 2017	n/s (67–98) 64% female	30	Experiment (RCT); mixed methods; control: standard care 12 weeks	Observations	Significantly more positive facial expressions. More encouraged interactions.	Catalyst for social interaction
McGlynn et al., 2017	72.17 (67 - 80) f:15; m:15	30	A within-participant variable and was defined as pre- or post-interaction with PARO	Interviews	Paro useful for people with mental or physical impairment or isolated.	Direct companion
Robinson et al., 2013	n/s (55–100) f:27; m:13	40	Experiment (RCT); control: activities as normal (e.g. interacting with resident dog)	UCLA; Observations	Loneliness change over time, more companionship	Catalyst for social interaction

			12 weeks			
Wu et al., 2016	74.6 (64-88) f:16; m:4	20	Two qualitative data collection methods, focus group discussions and semi-Structured interviews were used.	Interviews	Not for participants but for frail or very old or disabled	-

The number of participants ranged from 10 to 40 per article (M = 27.08, SD = 10.01). Studies included both female and male participants, with an overall average of 16.10 female participants and an average of 9.00 male participants taking part in the studies. All studies focused on the elderly population i.e., older adults with an overall average age of 79.52. The articles that reported on mental capacity or mental impairment, focused on patients with some form or level of dementia (Casey et al., 2020; D´Onofrio et al., 2019; Fogelson et al., 2021; Barrett et al., 2019; Liang, 2017), a mild cognitive impairment (Wu et al., 2016) or healthy older adults (McGlynn et al., 2017). Most of the companion and social robots were developed in the context of mental health and improving overall quality of life, loneliness, or depression.

Table 3.

Setting of Studies included in final Review.

Country of Research	Number of Studies	Authors
UK / Italy / Ireland	2	Casey et al., 2020; D´Onofrio et al., 2019
France	1	Wu et al., 2016
Taiwan	2	Chen et al, 2020; Chen et al., 2022
United States	4	Fogelson et al., 2021; Hudson et al., 2020; McGlynn et al., 2017; Banks et al., 2008
New Zealand	2	Robinson et al., 2013; Liang et al., 2017
Ireland	1	Barrett et al., 2019

Quality of the Included Studies

The final set of included studies in the review, were assessed in their quality with the use of the "Quality Assessment" by Silke ter Stal as used in her dissertation ("Look Who´s Talking", 2021). All of the included articles in the review received a quality assessment of "low", this meaning the strength of their conclusion is less than optimal (Table.4).

Table 4.

Quality Assessment Stages

Article	Quality Level	Participants
Banks et al., 2008	low	38
Barrett et al., 2019	low	10
Casey et al., 2020	low	38
Chen et al., 2020	low	20
Chen et al., 2022	low	25
D´Onofrio et al., 2019	low	38
Fogelson et al., 2021	low	18
Hudson et al., 2020	low	20
Liang et al., 2017	low	30
McGlynn et al., 2017	low	30
Robinson et al., 2013	low	40
Wu et al., 2016	low	18

Effects of the Interventions on Loneliness

Details about Companion Robots

The interventions included in the scoping review included either the use of the companion robot PARO or the Companion robot MARIO, with both robots being of a completely different design and interface. In the following, the two robots are further described in detail.

PARO

Paro is a robot developed in Japan modelled after a Canadian baby seal, covered in fur with the intention to promote engagement and elicit positive emotions such as relaxation and happiness specifically designed as a therapeutic tool. PARO (Personal assistive robot) as shown in figure 2, has five sensors for sound, touch, light, temperature and posture. PARO is special due to its humanlike emotional reactions such as happiness, anger and its diurnal rhythm. So far, Paro has been used not only to alleviate depression or issues with cognitive impairment but also to improve overall mental health and well-being (Chen et al., 2020; Chen et al., 2022; Fogelson et al., 2021; Liang et al., 2017; McGlynn et al., 2017; Robinson et al., 2013).

MARIO

A multidisciplinary consortium of trans-European researchers and other experts of the field from six different countries created the MARIO robot with the focus on creating a social robot that aims at supporting the psychological wellbeing of people with dementia. MARIO as shown in Fig 3, i.e. the Managing active and healthy Aging with the use of Caring Service Robots Project, uses a platform developed by Robosoft for robots called Kompai 2. MARIO is equipped with sensors and a camera for indoor navigation, obstacle detection and avoidance as well as a tablet on the robots´ torso area with which people can interact. The social robot has a humanoid appearance, is 1.5 meters tall with a white façade, large animated eyes, and can be activated by touch or sound. The MARIO companion robot in its final stage is also equipped with the following apps: my Music app, my Reminiscence App, my News app, my Games app, my Calendar app, my Family and Friends app and the Comprehensive Geriatric Assessment (CGA) (D´Onofrio et al., 2019; Casey et al., 2020; Barrett et al., 2019).

Fig 2. PARO companion robot

Fig 3. MARIO robot

Measure of Loneliness

The articles included in the review used different methods for measuring loneliness in the participants of their respective studies. Of the 12 included articles and their main measure of loneliness, four used the UCLA Loneliness Scale (Version 3), five used Interviews, and three used Observations. The Research papers also included other measures, that did not specifically measure loneliness, but which gave insight into the participant's mental health. The other measures included the Global Deterioration Scale (GDS), Geriatric Depression

Scale-Short Form (GDS-SF), the (modified-) Lexington Attachment to Pets Scale (LAPS/ MLAPS) and the Mini-Mental State Examination (MMSE). The Loneliness measures included the UCLA a 20 item scale which was developed by Daniell Rusell, Letitia Peplau, and Mary Ferguson in 1978 to assess adolescents and adults loneliness indirectly by investigating its hypothesized causes or correlated constructs (e.g. lacking companionship or feeling shy) (Ryan et al., 2015). The Friedman's ANOVA used by the researchers (Chen et al., 2020, Fogelson et al., 2021, Robinson et al., 2013 etc.) found significant positive changes in loneliness.

Positive Effects

The articles reported that companion robots are showing a promising positive effect on decreasing loneliness in the elderly population. The main goal of decreased loneliness in the elderly occurred with a direct link being made in the use of a companion robot to minimise loneliness and studies found exactly this (Casey et al., 2020; Chen et al., 2020; Fogelson et al., 2011; Robinson et al., 2013; Banks et al., 2008). This direct link was achieved, by creating a connection with the participants, through the interactions the robot can create. The companion robots had numerous positive mental and social impacts, such as improving loneliness and overall mental well-being, as well as creating possibilities for connecting with other elderly people, carers and family.

A positive aspect that was increased was the social interaction between the elderly and their carers and family members, which was motivated through the companion robot. This is done by giving participants something to talk about with others and therefore helping the elderly forge connections, as was concluded by statements made by the elderly, their family members and their carers (Casey et al., 2020; Chen et al., 2020; Hudson et al., 2020; Robinson et al., 2013). It was noted by individuals, that by sharing their pet in a common area, they were able to potentially connect with individuals who they had not previously had the opportunity to interact with (Hudson et al., 2020).

Participants specifically mentioned the level of companionship that was increased or the improvement of interpersonal relationships (Chen et al., 2020; Liang et al., 2017). While it was also found that participants´ social connectedness improved allowing for more frequent interactions with others (Barrett, 2019) and significantly more positive facial expressions were shown (Liang et al., 2017). These positive facial responses of individuals in the study of Liang et al., (2017) included smiling, laughing and portraying a happy or amused state in interacting with Paro the social robot.

Hudson et al., (2020) found that the elderly participants had built a strong connection to the companion robot and were sad to see it go. Findings revealed that positive perceptions of MARIO the social robot were shown in that the elderly individuals would personify the robot in referring to it as “he” or “she”, therefore conceptualising it as an embodied presence (Casey et al., 2020). Caregivers also found that Paro´s soft fur texture was soothing for patients and that in stressful situations Paro was able to calm the individual down (Liang et al., 2017).

Negative Effects

Some of the studies brought forth some unintended issues and negative effects in the use of the companion robot. Such a negative effect occurred in some of the participants when, after the intervention period, the companion robot was then taken away (Hudson, 2020). This effect occurred due to participants already creating a bonding experience with the companion robot. The individuals had personified and become attached to the companion robot, they wanted the companion robot to stay and continue to invoke the happy feelings they had received with the robot in use (Hudson et al., 2020). When the intervention was finished and it was necessary to return the companion robot, individuals became saddened that they would no longer be able to interact and communicate with the artificial agent.

Another unintended issue that arose was that the elderly did not identify with being frail or in need of assistance. Companion robots or social agents have in their eyes been branded for such a target group (i.e., people with dementia or some form of mental incapacity) with six of the seven studies, that reported on mental health, focusing on the target group of mentally impaired older adults rather than elderly of regular mental status (McGlynn, 2017; Wu, 2016). This view of the participants gave them the feeling that they could not relate to the companion robot and its use and that they did not see themselves as needing such a technology. In their opinion such a device was more for people who were old, frail or alone (McGlynn, 2017; Wu, 2016).

Factors influencing Use

Three articles gave insight into both the impact of a companion robots on loneliness and social isolation in the elderly, as well as information regarding the attitude of the elderly and their acceptance of social or companion robots. The three articles that did that are mentioned below (D´Onofrio et al., 2019; McGlynn et al., 2017; Wu et al., 2016).

Acceptance and Attitudes

Previous investigations into acceptance have found that there are issues that are mainly due to the attitude that individuals have towards the use and implementation of new technologies. In the study by Wu et al., (2016) researchers found that half of their participants would agree with the idea of accepting and taking home a robot if it were available to them, this despite the fact that they to some extent had negative attitudes towards the robots (Wu et al., 2016). Participants that live independently gave in total over 93 mentions, via interviews and gathered data on Pre- and Post-interaction attitude tests, of positive attributes and only a total of 11 negative attributes, with participants having a very positive attitude toward PARO´s characteristics (McGlynn et al., 2017). An example of some of these positive attributes that participants liked were the terms "fur" therefore meaning the participants enjoyed Paro´s fur. Other terms included "colour", "cuteness", "animal likeness" and "cuddliness" (McGlynn et al., 2017).

In the study by D´Onofrio et al., (2019), participants attitudes were measured via the amount of excitement and expressiveness they displayed during their engagements with MARIO (i.e. via their facial expressions). Participants in Ireland had both the highest score in expressiveness and excitement out of the three intervention sites followed by Italy and the UK. In Ireland, excitement ranged from positive to very positive interactions in their displayed attitudes toward MARIO (D´Onofrio et al., 2019). In Italy, the elderly displayed high levels of expressiveness meaning they showed a positive attitude in their engaging with MARIO. However, in the UK there were a range of expressiveness of older adults therefore indicating a large variableness in their attitudes toward MARIO including a positive and negative attitude (D´Onofrio et al., 2019).

Discussion

The aim of this scoping literature review was to evaluate to what extent companion robots are able to diminish loneliness in the elderly. Additionally, identifying whether companion robots are effective in diminishing loneliness in the elderly by identifying positive and negative effects, as well as the identification of factors that influence older adult's use of the companion robots. Studies that were included in the literature review found more positive accounts on the effects of companion robots such as PARO and MARIO, than negative. Companion robots were found to initiate an increase in mental wellbeing as well as social connectedness and interactions amongst individuals. This result provides insight that interventions using companion robots can be effectively used in diminishing loneliness. In

addition, it was found that acceptance significantly influenced the extent to which the elderly would engage and initiate contact with the companion robots, with their attitude beforehand affecting the elderly's acceptance. It is therefore possible to state that the known factors that influence the older adult's use of companion robots is the attitude and acceptance towards such technology.

In regards to the quality assessment, all studies were deemed as being of low quality. It is however questionable whether the studies included are of low quality merely because they have less than 50 participants in their respective studies. With the use of the quality assessment by Silke ter Stal, many steps regarding the assessment remain unclear therefore leaving much room for interpretation and difficulty in the replication of such an assessment. Due to the variability in such scoping reviews, it is necessary to find a methodological standardization to be able to ensure the strength and utility of the evidence found (Pham et al., 2014). With no standardization of a methodological quality assessments and few literature reviews in the past using such an assessment, there remains a limitation already mentioned by a number of reviews (Pham et al., 2014). Once more, it seems disrespectful on a professional level to categorise the quality of authors´ studies as low merely because they had less than 50 participants. In social psychological studies, sample sizes may vary. It may be necessary to investigate effect and sample sizes with comparable study designs in the same subject and field using the same type of manipulation of measuring variables to remain realistic (Lovakov & Agadullina, 2021). A concrete solution would be to implement a quality assessment that focuses on what can be found in available literature, such as finding studies of low quality if they do not use concrete and standardized measures for loneliness. This means that the content is regarded higher than for example the amount of participants that took part, as creating and conducting such clinical studies is often too expensive and difficult to produce. In changing the focus of the quality assessment to investigate the content, rather than the criteria of low participants, allows for better and more qualitative productive values.

Another topic of discussion is that of the way companion robots are seen by individuals and the way they are portrayed by the creators and implementers of such technologies. There is missing information regarding the marketing of social and companion robots for the elderly, by the companies and people creating the interventions, as to date there seem to be no investigations in this area. Within the included articles in this scoping review, two articles had a recurring negative mentioning of companion robots and that was the fact that the elderly did not see themselves as needing such an assistive technology. These articles (McGlynn et al.,

2017 & Wu et al., 2016) had individuals who found the companion robots to be interesting and somewhat useful, however not particularly for themselves. This was due to the image of such technology, that it is for the "very old" who need assistance (Wu et al., 2016). It was also stated that individuals found this assistive technology to be for the "frail" or the "physical or mentally impaired" (McGlynn et al., 2017). If marketing was directed more generally and inclusive of all age groups, including healthy adults as well as the mentally impaired, then people might not feel labelled if they use such a technology. They then may not only accept the technology but also will accept it for themselves and use such a technology. In the study by Kulviwat, et al., (2007) it was found that marketing managers of such technology industries must adapt and understand that behind the adoption of technological products lies the emotional reaction. When individuals feel pleasantness or arousal, this influences their attitude and their attitude influences their acceptance of technology therefore defining their extent to which they use a technology (Kulviwat, et al., 2007). It is therefore important to direct the marketing of companion robots in the direction of entertainment and pleasantness rather than that of an aid for people who are lacking something. This could help in implementing interventions and creating an environment where people feel more comfortable to use such a technology. Researchers and developers should be careful in their choice of words and their "marketing" strategy to enable widespread inclusivity in usage.

Additionally, there is evidence that suggests that is it necessary to investigate the acceptance and attitude towards companion robots and their use via models such as the TAM, UTAUT or ALMERE model; however, there remains a lack of evidence on this topic being studied (Wu et al., 2016). There is still little knowledge or in-depth studies about older adults´ needs in relation to the use of robots or about how the elderly perceive robots or react to their use in elderly care (Wu et al., 2016; Heerink et al., 2010). Furthermore, there is also different types of acceptance; one would be social acceptance i.e. acceptance of the robot as a conversational agent with a pet-like or human relationship or connection, the other would be functional acceptance i.e. the acceptance of the robots functionalities in terms of ease of use and usefulness (Heerink et al., 2010). Heerink et al., (2008) stated that in order for a robot acceptance model to be successful, it needs to have both the inclusion of functional acceptance and social acceptance. A solution would be to increase investigations into the acceptance of companion robots using for example the UTAUT, extending the focal point to include the distinction between functional and social acceptance, and targeting specifically the acceptance of the older generations for which the companion robots are eligible.

Limitations

The discussion points mentioned above depict areas for which there may be a better solution. In addition to the discussion points, there are also some limitations to the scoping review, one of which was that of the process of the literature search wherein the inclusion and exclusion criteria were decided upon. An individual researcher did this study and therefore there was only one opinion. Reviews in general, but also in this field and area of study, typically use numerous researchers with distinct choices being made and then discussed as seen in multiple reviews such as Budak et al., 2021; Conti et al., 2021; Koh et al, 2021 and more. Specifically for this study, it was a limitation that there was only one researcher deciding on the process. Beside this as mentioned above, the quality assessment and therefore the labels given to the articles remains questionable.

Another limitation was the differentiation of the researchers´ choice in the measure of loneliness. Articles referenced loneliness in their title or articles introduction but there would be no further investigation using a concrete measure (e.g. standardised measurement of loneliness). The articles that did use a measure (e.g. Fogelson et al., 2021., Robinson et al., 2013 etc.) did not explain or go into detail about why that specific measure was used. It was therefore unclear whether a comparison could be made between the studies and it would not be possible to derive a conclusion regarding the effectiveness between studies and their outcomes. A simple solution would be for researchers to develop or use one of the existing loneliness scales, such as the UCLA (Russell et al., 1978) or the loneliness-harmonised standard (Office for National Statistics, 2018).

Finally, a limitation encountered is regarding the description and stage in which the robot was used. In none of the articles did researchers disclose at what stage the MARIO or PARO companion robot were. It is therefore unclear if all companion robots mentioned were in the same stage of development or if any improvements or changes had been made. This meaning it is difficult to make a concrete statement regarding which robot may have had more improvements on the loneliness of the elderly. The limitations mentioned above, make it difficult to compare findings of the multiple studies and to create a grounded understanding, as the large variety in what and how particular companion robots are researched remains unclear. Silke ter Stal (2021) also found this issue, wherein it is mentioned that there is a need for more homogeneity amongst studies regarding ECA’s (i.e. Embodied Conversational Agents), however this is also the case for companion robots in order to have more generalizability.

Conclusion

This scoping literature review provided insights into available companion robots used to decrease loneliness in older adults. Therefore, the effectiveness and the acceptance and attitudes influencing their intention to use them were investigated. With mostly positive experiences mentioned by participants the goal of decreasing loneliness through companion robots seem to be promising, however further research is necessary in the areas of predicted use and investigations into the acceptance of such robots by the elderly. It should be noted that due to the small sample sizes the reported outcomes need to be interpreted with caution. Future research should investigate what the elderly need regarding the robots functionality and what they expect concerning social needs for them to accept and use companion robots. Additionally, research should also focus on investigating older adults´ acceptance in the use of companion robots, more specifically focusing on their needs, attitudes and preferences. Researchers should focus on creating a standardised measurement of loneliness and a concrete and standard setting etc. for how an intervention should be executed, in investigating how companion robots help alleviate loneliness in the elderly.

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