DOI: 10.22456/2316-2171.142846 *Short Paper*

Enhancing older adults care through social robots: Addressing aspects of well-being with innovative solutions

Melhorando o cuidado dos idosos por meio de robôs sociais: Abordando aspectos de bem-estar com soluções inovadoras

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Abstract: Objectives: To explore aspects of health and well-being of older adults that can be supported by social robots from a co-design perspective. Methods: A qualitative exploratory approach was used, involving a literature review and the support of a Large Language Model (ChatGPT 4o) to identify aspects of well-being, the application of assessment scales, and activities that can be performed by social robots. Scores for relevance, feasibility, and suitability were assigned based on the researchers' expertise. Results: Twenty-four aspects of well-being were identified and categorized into five domains, totaling 81 assessment scales that can be performed by social robots, as well as a set of activities to improve the well-being of older adults that can be supported by social robots. Conclusion: Social robots have diverse potential to support health assessment and activities that can potentially enhance the well-being of older adults. Such activities are relevant and feasible for automation through social robots.

Keywords: Social robots. Well-being. Automation. Health.

Resumo: Objetivos: Explorar aspectos de saúde e bem-estar de idosos que podem ser apoiados por robôs sociais a partir de uma perspectiva de co-design. Métodos: Foi usada uma abordagem qualitativa exploratória, envolvendo uma revisão da literatura e o apoio de um Modelo de Linguagem de Grande Escala (ChatGPT 4o) para identificar aspectos de bem-estar, a aplicação de escalas de avaliação e atividades que podem ser realizadas por robôs sociais. Pontuações para relevância, viabilidade e adequação foram atribuídas com base na expertise dos pesquisadores. Resultados: Vinte e quatro aspectos de bem-estar foram identificados e categorizados em cinco domínios, totalizando 81 escalas de avaliação que podem ser realizadas por robôs sociais, bem como um conjunto de atividades para melhorar o bem-estar de adultos mais velhos que podem ser apoiados por robôs sociais. Conclusão: Robôs sociais têm um potencial diversificado para apoiar a avaliação de saúde e atividades que podem potencialmente melhorar o bem-estar de adultos mais velhos. Tais atividades são relevantes e viáveis para automação através de robôs sociais.

Palavras-chave: Robôs sociais. Bem-estar. Automação. Saúde.

Introduction

The global demographic landscape is undergoing a significant transformation, with the proportion of older adults increasing at an unprecedented rate. According to the World Health Organization (WHO), by 2030, one in six people worldwide will be aged 60 years or over, with the number of people aged 60 years and older projected to double from 1 billion in 2020 to 2.1 billion by 2050. This demographic shift brings health challenges that require innovative approaches to healthcare and quality of life improvement (WHO, 2022).

Traditional healthcare systems are increasingly strained, and there is a pressing need for technologies that can provide continuous, personalized, and engaging support to older adults. Social robots, equipped with advanced artificial intelligence (AI) and interactive capabilities, have emerged as a promising solution to assist older adults in managing aspects of well-being effectively (Broekens; Heerink; Rosendal, 2009). These robots can offer companionship,

cognitive stimulation, emotional support, and assistance with daily activities, thereby enhancing the overall well-being of older adults (UN DESA, 2023).

Despite the potential benefits of social robots, comprehensive research on their specific impact on older adults' well-being is still lacking. Studies have shown that social robots like Paro can reduce stress and foster bonds, while others address social isolation and provide therapeutic interventions (Wada et al., 2003; González-González et al., 2021; Pu et al., 2019; Araujo et al., 2022). This paper aims to fill this gap by examining how social robots can manage cognitive, emotional, and physical health challenges, with the goal of integrating them into older adults' care practices to improve quality of life (Pu et al., 2019).

To ensure these technologies meet the specific needs and preferences of older adults, it is essential to involve them in the design process through co-design. Co-design not only enhances the usability and acceptance of social robots but also empowers older adults by giving them a sense of ownership and value. This participatory approach helps uncover practical issues and potential improvements that may not be evident to developers alone, leading to more effective and inclusive solutions (Sanders; Stappers, 2008).

The primary goal of this paper is to present the results of a study that evaluated the potential of social robots in enhancing the health and well-being of older adults. This includes identifying key aspects of well-being that social robots can address, analyzing the effectiveness of these robots in managing cognitive impairments, emotional well-being, and chronic diseases, assessing the feasibility and suitability of co-designing social robots with older adults, and providing recommendations for their development and implementation in elderly care settings.

This study contributes to the field of gerontechnology by offering a detailed analysis of the application of social robots in older adults' care. Its technical-scientific relevance lies in its potential to inform the development of more effective, user-centered social robots that can significantly improve the quality of life for older adults. By providing a comprehensive overview of the benefits and challenges associated with using social robots, this paper aims to advance the understanding and adoption of these technologies in healthcare settings.

This paper aims to provide a comprehensive understanding of how social robots can support the health and well-being of older adults, offering valuable insights for researchers, practitioners, and policymakers in gerontechnology.

Materials and methods

Study design: This qualitative exploratory study aims to construct a comprehensive conceptual framework to address aspects of well-being among older adults using social robots. The primary objective was to develop this framework by synthesizing insights from existing literature and leveraging advanced AI tools for data gathering and analysis.

Literature review: A thorough literature review was conducted to identify and compile aspects of well-being commonly associated with older adults. This process involved searching various academic databases and journals to gather relevant studies and reports. The literature review served as the foundation for identifying key aspects of well-being that social robots could potentially address.

Utilization of Large Language Model (LLM): To enhance the comprehensiveness and accuracy of our framework, we employed ChatGPT 4.0, an advanced LLM, as an auxiliary tool. The LLM generated a comprehensive list of aspects of well-being affecting older adults, identified existing scales to assess these aspects, and suggested potential roles and tasks for social robots. An expert in information systems and social robotics guided the use of the LLM, ensuring precise and relevant prompt engineering. Additionally, gerontology specialists validated and refined the preliminary outputs. This multidisciplinary approach ensured the reliability and validity of the data. The justification for using ChatGPT 4.0 lies in its ability to efficiently process and analyze vast amounts of data, providing a comprehensive overview of existing knowledge and potential applications. This innovative use of AI represents a novel approach in constructing theoretical frameworks, contributing to the advancement of research methodologies in gerontechnology.

Framework development: The list, created through literature review and LLM support, included 24 aspects related to well-being, including some health issues and conditions: activities of daily living, anxiety, attention state, chronic diseases management, cognitive engagement, cognitive impairment, dementia, depression, embodied abilities (physical functioning), frailty, functional abilities, general health perception, loneliness, memory function, mobility and gait, nutrition, pain, quality of life, sleep quality, social engagement and participation, social support, stress, urinary incontinence, and visual and hearing impairments. These aspects of well-being were categorized into five overarching domains: cognitive and mental health, quality of life and social well-being, physical health, general health, and daily living and sensory health. We chose not to use pre-existing categorizations, such as those from the United Nations or the World Health Organization, because we wanted the classification to emerge organically from our findings rather than conforming to predetermined structures. This approach allowed for a more tailored and relevant framework specific to the context of social robots and older adults.

Scale identification and analysis: For each well-being aspect, we researched existing scales commonly used in the field. For cognitive impairment, for example, we identified scales such as the Mini-Mental State Examination (MMSE), Montreal Cognitive Assessment (MoCA), and the Clock Drawing Test. This step aimed to evaluate the potential of social robots to automate these assessments, thus facilitating more efficient and consistent assessments. To evaluate the potential of social robots to automate the assessment of these scales, we

assessed each scale based on two criteria: relevance for older adults (evaluates whether it would make sense and be relevant for older adults to have a robot automatically perform the assessment) and technical feasibility (evaluates the technical viability of automating the assessment of the scale using current technology). Each criterion was rated on a scale from 1 to 5. These evaluations were conducted for each identified scale, providing a comprehensive understanding of the potential and limitations of automating scale assessments with social robots.

Moreover, we explored various tasks that social robots could perform to aid older adults in managing well-being. For example, in also addressing cognitive impairment, social robots could engage them in cognitive exercises, games, and activities designed to stimulate cognitive functions. This analysis was aimed at identifying practical applications of social robots in enhancing the health and well-being of older adults. To prioritize the aspects of well-being for robot intervention, we assigned scores based on three criteria: relevance (the importance of addressing the well-being aspect), feasibility and ease of development (the practicality and technical feasibility of developing robot interventions), and suitability for co-design (the potential for involving older adults in the design process). Scores were assigned on a scale from 1 (very low) to 5 (very high). This evaluation helped in identifying the most promising areas for robot intervention.

Results and discussion

The results of this study provide a comprehensive evaluation of the potential of social robots in enhancing the health and well-being of older adults. Tables 1 to 5 present the evaluation of various well-being scales across five domains: cognitive and mental health, quality of life and social well-being, physical health, general health, and daily living and sensory health. Each table lists the scales and their scores for Relevance (R) and Feasibility (F), where Relevance indicates the importance and suitability of robot automation for older adults, and Feasibility assesses the technical viability of implementing such automation. The scores range from 1 (very low) to 5 (very high), offering a comprehensive understanding of the potential and limitations of automating these assessments with social robots.

The evaluation results in Tables 1 to 5 reveal the potential of social robots to automate the assessment of various well-being scales for older adults. Our analysis shows that most aspects hold medium to high relevance for older adults when automated by social robots. Notably, we did not assign any aspect a relevance score of 1, and only one aspect received a score of 2. This specific aspect, the "Reading Level/Reading Interest Inventory (RL/RI16)" in the cognitive and mental health domain, was rated lower due to its specialized nature, which may not be as broadly applicable or beneficial for automation compared to other scales.

Regarding feasibility, no aspects were rated with scores of 1 or 2, indicating that the automation of these assessments is generally viable. Most scales received a feasibility score of 4, suggesting that while there are some technical challenges, they are not insurmountable with current technology.

Table 1 | Cognitive and mental health domain (scales)

Aspect	Scales	R	F
Cognitive impairment	− Mini-Mental State Examination (MMSE)	4	4
	− Montreal Cognitive Assessment (MoCA)	4	3
	− Clock Drawing Test	3	3
Dementia	− Alzheimer's Disease Assessment Scale-Cognitive (ADAS-Cog)	3	3
	− Dementia Rating Scale (DRS)	3	3
	− Global Deterioration Scale (GDS)	3	3
	− Hasegawa's Dementia Scale-Revised (HDS-R)	3	3
Memory function	− Wechsler Memory Scale (WMS)	3	3
	− California Verbal Learning Test (CVLT)	4	3
	− Rivermead Behavioural Memory Test (RBMT)	3	3
	− Reading Level/Reading Interest Inventory (RL/RI16)	2	3
Depression	− Geriatric Depression Scale (GDS)	5	5
	− Patient Health Questionnaire-9 (PHQ-9)	5	4
	− Hamilton Depression Rating Scale (HDRS)	4	3
	− Depression Anxiety Stress Scales (DASS)	5	4
Anxiety	− Geriatric Anxiety Inventory (GAI)	5	4
	− Hamilton Anxiety Rating Scale (HAM-A)	4	3
	− Beck Anxiety Inventory (BAI)	5	4
	− Depression Anxiety Stress Scales (DASS)	5	4
Attention state	− Trail Making Test (TMT)	3	3
	− Continuous Performance Test (CPT)	3	3
	− Stroop Test	3	3
	− Sustained Attention to Response Task (SART)	3	3
Stress	− Perceived Stress Scale (PSS)	5	4
	− Geriatric Anxiety Inventory (GAI)	5	4
	− Cohen-Hoberman Inventory of Physical Symptoms (CHIPS)	4	4
	− Depression Anxiety Stress Scales (DASS)	5	4
Cognitive engagement	− Cognitive Activity Scale (CAS)	3	3
	− Cognitive Engagement Scale (CES)	3	3
	− Cognitive Reserve Index Questionnaire (CRIq)	3	4

Source: Own authorship.

Noteworthy are the scales that received dual scores of 5 for both relevance and feasibility: the Geriatric Depression Scale (GDS) and the Body Mass Index (BMI). The GDS, a key tool for assessing depression among older adults, is both highly relevant and technically feasible for social robots to

administer and score due to its simplicity. Similarly, the BMI is crucial for assessing nutritional status and overall health, with with its ease of calculation and widespread use making it highly feasible for automation by social robots.

Table 2 | Quality of life and social well-being domain (scales)

Aspect	Scales	R	F
Quality of life	– World Health Organization Quality of Life-BREF (WHOQOL-BREF)	5	4
	– Short Form Health Survey (SF-36)	5	4
	– EuroQol-5 Dimension (EQ-5D)	5	4
	– Quality of Life in Alzheimer's Disease (QoL-AD)	5	4
	– Older People's Quality of Life Questionnaire (OPQOL)	5	4
Social support	– Multidimensional Scale of Perceived Social Support (MSPSS)	5	4
	– Social Support Questionnaire (SSQ)	4	4
	– Lubben Social Network Scale (LSNS)	4	4
Social engagement and participation	– Social Engagement Scale (SES)	4	4
	– Community Integration Questionnaire (CIQ)	4	4
	– Participation Measure for Post-Acute Care (PM-PAC)	4	4
Loneliness	– UCLA Loneliness Scale	5	4
	– De Jong Gierveld Loneliness Scale	5	4
	– Loneliness Scale (short-form)	5	4

Source: Own authorship.

Table 3 | Physical health domain (scales)

Aspect	Scales	R	F
Functional abilities	– Barthel Index	4	4
	– Katz Index of Independence in Activities of Daily Living (ADL)	4	4
	– Lawton Instrumental Activities of Daily Living Scale (IADL)	4	4
Pain	– Visual Analog Scale (VAS)	4	5
	– Numeric Rating Scale (NRS)	4	5
	– McGill Pain Questionnaire	4	4
Mobility and gait	– Timed Up and Go (TUG) Test	4	4
	– Gait Speed Test	4	4
	– Functional Reach Test	4	4
	– Get-up-&-go Test	4	4
Frailty	– Fried Frailty Criteria	4	4
	– Frailty Index (FI)	4	4
	– Clinical Frailty Scale (CFS)	4	4
Embodied abilities	– Timed Up and Go (TUG) Test	4	4
	– Short Physical Performance Battery (SPPB)	4	4
	– Berg Balance Scale	4	4

Source: Own authorship.

Table 4 | General health domain (scales)

Aspect	Scales	R	F
Sleep quality	– Pittsburgh Sleep Quality Index (PSQI)	4	4
	– Epworth Sleepiness Scale (ESS)	5	4
	– Insomnia Severity Index (ISI)	4	4
Nutrition	– Mini Nutritional Assessment (MNA)	5	4
	– Malnutrition Universal Screening Tool (MUST)	4	4
	– Body Mass Index (BMI)	5	5
General health perception	– General Health Questionnaire (GHQ)	4	4
	– SF-12 Health Survey	4	4
	– Health Status Questionnaire (HSQ)	4	4
Chronic diseases management	– Charlson Comorbidity Index (CCI)	4	3
	– Chronic Disease Self-Efficacy Scales	4	4
	– Self-Management Ability Scale (SMAS)	4	4

Source: Own authorship.

Table 5 | Daily living and sensory health domain (scales)

Aspect	Scales	R	F
Activities of daily living	– Functional Independence Measure (FIM)	4	3
	– Assessment of Motor and Process Skills (AMPS)	4	4
	– Performance Assessment of Self-Care Skills (PASS)	4	4
Urinary incontinence	– International Consultation on Incontinence Questionnaire (ICIQ)	4	4
	– Incontinence Severity Index (ISI)	4	4
	– Urinary Incontinence Scale (UIS)	4	4
Visual and hearing impairments	– Snellen Chart (for visual acuity)	4	4
	– Hearing Handicap Inventory for the Elderly (HHIE)	4	4
	– Audiometry (for hearing assessment)	4	3

Source: Own authorship.

Overall, the findings suggest that automating the assessment of well-being scales using social robots is both relevant and feasible for most aspects evaluated. This indicates a strong potential for social robots to enhance the assessment and management of older adults' well-being, providing consistent and efficient support.

The results presented in Tables 6 to 10 further demonstrate the potential of social robots in enhancing older adults' well-being across various domains by automating relevant

activities. In these tables, R represents Relevance, F represents Feasibility and ease of development, and S represents Suitability for co-design.

Table 6 | Cognitive and mental health domain (activities)

Aspect	Goals/tasks	R	F	S
Cognitive impairment	Engage in cognitive exercises, games, and activities that stimulate cognitive functions.	4	3	2
Dementia	Provide reminders, engage in memory exercises, and offer companionship to help manage symptoms.	2	2	2
Memory function	Assist with memory training exercises and provide regular mental challenges to improve memory.	4	3	3
Depression	Offer companionship, engage in conversations, and encourage social interaction, which can help alleviate depression.	4	4	4
Anxiety	Offer reassurance, engage in calming activities, and provide a sense of security, which can help reduce anxiety.	3	3	4
Attention state	Conduct attention-enhancing games and tasks, helping to improve focus and attention span.	3	3	3
Stress	Guide relaxation exercises, offer stress-relief tips, and provide supportive interaction to reduce stress.	3	4	4
Cognitive engagement	Involve users in engaging activities that challenge cognitive skills and maintain mental sharpness.	4	3	3

Source: Own authorship.

Table 7 | Quality of life and social well-being domain (activities)

Aspect	Goals/tasks	R	F	S
Quality of life	Contribute to an improved quality of life by providing companionship, engaging in enjoyable activities, and offering emotional support.	3	4	3
Social support	Facilitate social interaction, remind users of social activities, and provide emotional support.	5	5	5
Social engagement and participation	Encourage participation in social activities, facilitate communication with family and friends, and help maintain social connections.	5	5	5
Loneliness	Provide companionship, engage in regular interactions, and help users feel less isolated.	5	5	5

Source: Own authorship.

Table 8 | Physical health domain (activities)

Aspect	Goals/tasks	R	F	S
Functional abilities	Assist with activities of daily living, such as dressing, grooming, and meal preparation, to maintain independence and functionality.	4	2	2
Pain	Provide distraction techniques, offer pain management strategies, and assist with medication reminders to alleviate pain.	3	2	2
Mobility and gait	Encourage physical activity, provide balance exercises, and assist with mobility aids to improve movement and stability.	4	2	2
Frailty	Implement strength-building exercises, encourage gentle physical activity, and monitor for signs of decline to mitigate frailty.	2	2	2
Embodied abilities (physical functioning)	Support physical rehabilitation exercises, encourage movement, and monitor physical health indicators to maintain overall functioning.	2	2	2

Source: Own authorship.

Table 9 | General health domain (activities)

Aspect	Goals/tasks	R	F	S
Sleep quality	Guide users through bedtime routines, offer relaxation exercises, and monitor sleep patterns.	2	3	3
Nutrition	Offer meal planning assistance, provide nutritional education, and encourage healthy eating habits to support overall health.	5	3	3
General health perception	Provide health education, monitor vital signs, and offer encouragement to promote a positive perception of health.	3	3	3
Chronic diseases management	Assist with medication management, provide symptom tracking tools, and offer support in adhering to treatment plans for chronic conditions.	5	2	3

Source: Own authorship.

The evaluation results presented in Tables 6 to 10 provide a

comprehensive analysis of the potential of social robots to automate various activities aimed at enhancing older adults' well-being. These tables illustrate a broader range of scores across Relevance (R), Feasibility and ease of development (F), and Suitability for co-design (S) compared to the scales evaluated in Tables 1 to 5.

Table 10 | Daily living and sensory health domain (activities)

Aspect	Goals/tasks	R	F	S
Activities of daily living	Assist with daily tasks, remind users to perform activities, and provide guidance on how to complete tasks.	2	2	2
Urinary incontinence	Implement bladder training techniques, provide reminders for scheduled bathroom breaks, and offer support with incontinence products and hygiene.	2	2	2
Visual and hearing impairments	Facilitate communication through alternative means (e.g., text-based or visual aids), offer assistance with adaptive devices, and provide support in navigating environments with impaired vision or hearing.	3	4	2

Source: Own authorship.

Several activities received scores of 2 across all three criteria, highlighting significant challenges. These include dementia management, frailty, embodied abilities, activities of daily living, and urinary incontinence. The lower ratings reflect the complex nature of these issues, substantial technological hurdles in developing feasible solutions, and difficulties in effectively co-designing with older adults.

Conversely, activities focused on enhancing social support and engagement, and reducing loneliness were rated highly, receiving scores of 5 in all three criteria. These activities are crucial for improving the quality of life for older adults, are technically feasible due to existing communication and interaction technologies, and are well-suited for co-design as they are relatable and engaging for older adults.

Overall, these findings underscore the diverse potential of social robots in automating activities to support older adults' health and well-being. They highlight the importance of continuous technological innovation and active involvement of older adults in the development process to address the varied challenges and maximize the effectiveness and acceptance of social robots in elderly care settings.

Conclusion

Social robots offer significant potential for enhancing the well-being of older adults. This study identified key aspects of well-being that can be addressed through the automation of assessments and activities by social robots. Most aspects demonstrated medium to high relevance and feasibility for automation, particularly those related to increasing social support and reducing loneliness. Continuous technological innovation and active involvement of older adults in the design process are crucial for ensuring the effectiveness and acceptance of social robots in elderly care. These findings highlight the importance of developing user-centered social robots to improve the quality of life for older adults.

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