

# Investigating Various Technologies Applied to Assist Seniors

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**Abstract.** This study undertakes a systematic literature review to investigate current empirical studies on the assistive technologies applied in aged care. Our systematic review of 54 studies published from 2000 to 2014 examines the role of assistive technologies in seniors' daily lives, from enhancements in their mobility to improvements in the social connectedness and decreases in readmission to hospitals. We found eight key issues in aged care that have been targeted by ICT researchers. We also identified the assistive technologies that have been proposed to overcome those problems, and we categorised these assistive technologies into six clusters. Our analysis showed significant growth in the number of publications in this area in the past few years. It also showed that most of the studies in this area have been conducted in North America.

## 1 Introduction

The number of old adults in our society is growing: in the Australia, the group of people aged 65 or older comprised 16% of the population in 2012, and by 2040 this percentage will be 25%<sup>1</sup>. This increase in the number of old adults will have a substantial impact on the healthcare system and society such as increasing number of old people with chronic diseases social inclusion and need for more professional caregivers [1].

Information and communication technology (ICT) applied in various field [2-8] and recently have transformed daily life of seniors and offer a great potential to improve the health of these group of people [9]. Various technologies, such as the robot, general ICT and sensor technology have been used to manage specific health problems [10]. These ICTs, which are commonly known as assistive technologies, are defined by Marshal (1997) [11] as “any item, piece of equipment, product or system, whether acquired commercially, off-the-shelf, modified or customized, that is used to increase, maintain or improve functional capabilities of individuals with cognitive, physical or communication disabilities”.

Studies demonstrate that ICT has been used for a variety of purposes to help seniors in their daily life. Assistive technologies have a wide range covering from computer use to the most advanced robot technology [12, 13]. Due to the above variability,

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<sup>1</sup> Australian Bureau of Statistics. Available at <http://www.abs.gov.au/>

however, there is lack of the studies to show the bigger picture and outcome of these technologies. Therefore, in this systematic literature review, we identify assistive technologies that are designed to help seniors in their daily life and relieve their problems. This study aims to fill the gap identified in the literature and provides a broader picture of elderly's problem and the various technology interventions proposed to help them. Therefore, this study poses the following research questions:

RQ1. What problems of the elderly have been targeted and investigated by ICT researchers?

RQ2. What technologies have been proposed for aged care problems?

This study contributes to the literature on assistive technologies in various ways. First, it furthers the attempt to identify seniors' problems and the technologies proposed to assist them. Second, the findings of this study should enable practitioners to better understand the various technologies. With this understanding, practitioners can better advise seniors as to how they might gain an improved quality of life through the use of appropriate assistive technologies.

## **2 Methodology**

To classify, assess and interpret the existing empirical studies and answer our research questions, a systematic literature review was conducted in this study[14]. Many studies have used the same approach [15-21]. Following the guidelines proposed by Kitchenham [14], we conducted the study in three stages, namely, planning, conducting, and reporting the review.

### **2.1 Search terms**

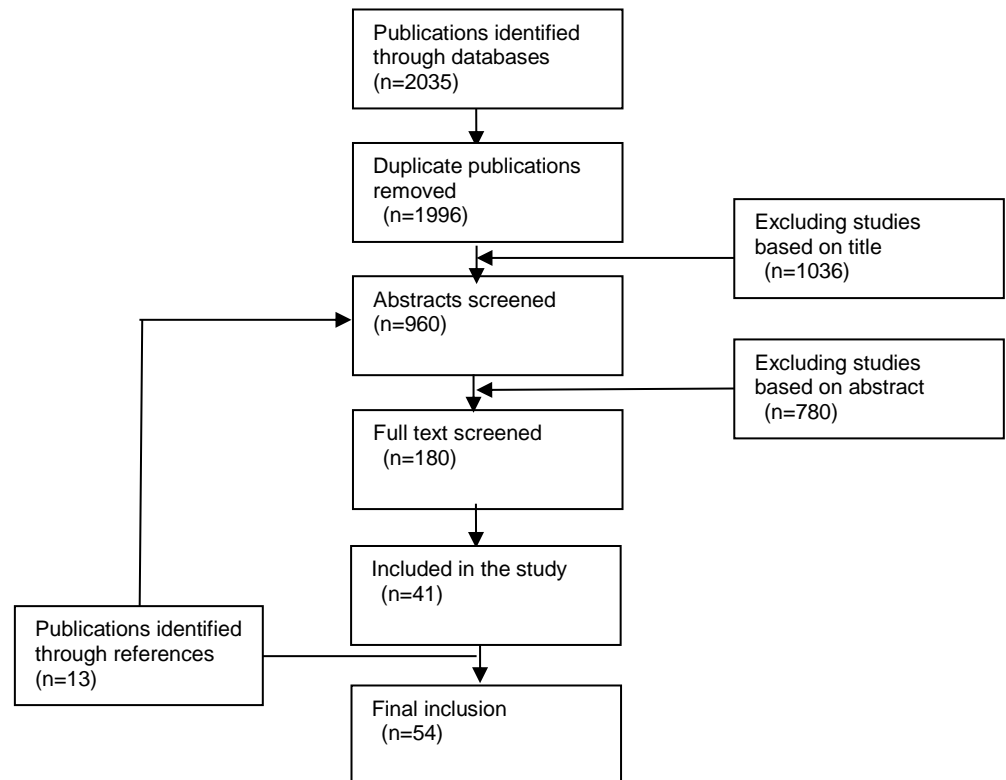
We undertook systematic searches using keywords of publications between 2000 to the present in the following databases: ScienceDirect, PubMed, ProQuest and IEEE Explore. The following keywords were used: ("elderly" or "older" or "aged" or "senior" or "elders") AND ("technology" or "adoption" or "benefits" or "information and communication technology" or "intervention") in the publication's titles, keywords, abstracts or full texts.

### **2.2 Inclusion/ exclusion criteria**

We included studies involving seniors aged 60 or older with different types of study designs. The studies had to include technologies related to aged care problems. We included studies that applied to help seniors and provide evidence of changes ranged in seniors' daily life. Studies in languages other than English were excluded.

## 2.2 Data extraction and synthesis

First, two authors independently reviewed the abstracts of the retrieved sources and agreed on the included articles. In total, 2069 titles and abstracts were screened to find the qualified studies for the review. Full papers of 248 studies were retrieved and evaluated by the authors. Based on the predefined criteria, 54 articles were included in this review (Fig 1). In addition, an independent reviewer independently evaluated the paper against the inclusion criteria. Subsequently, the key details were extracted and synthesised from the 54 studies included in our systematic review. For the analysis of the data and to draw diagrams we used Microsoft Excel.

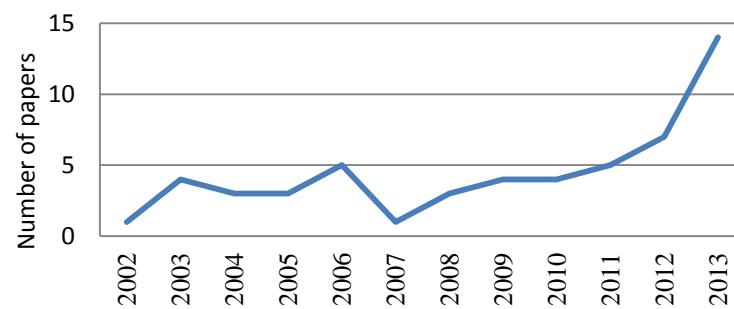


**Fig. 1.** Study selection procedures

### 3. Results

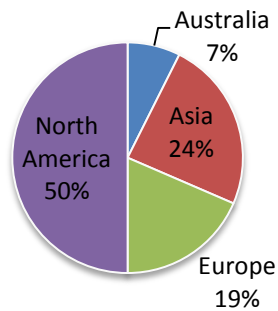
#### 3.1 Trends

The distribution of the included studies per year is shown in Figure 2. The number of studies noticeably increased in the past few years; this suggests that this area is increasingly attracting the attention of academics and practitioners because of the growth of the older population.



**Fig. 2.** Frequency of publications per year

Figure 3 shows that most of the included studies were conducted in North America and Canada (N=27, 50%) and Asia (N=13, 24%). The rest of the studies were conducted in Europe (N=10, 19%) and Australia (N=4, 7%).



**Fig. 3.** Number of publications per continent

### 3.2 Seniors' problems

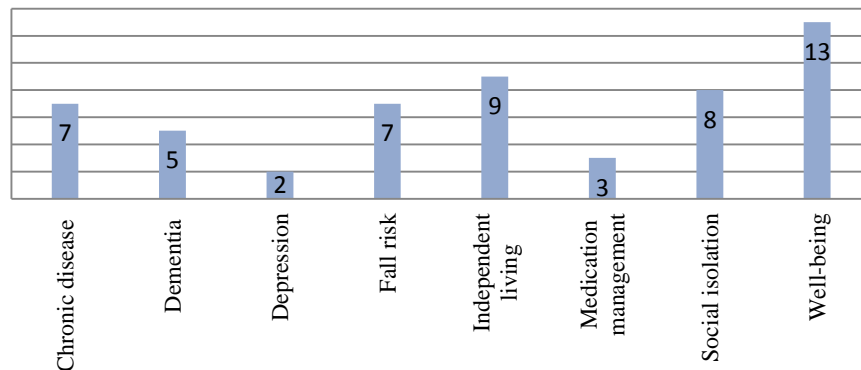
The analysed outcomes differed widely between the various studies. We found that the studies target eight older adults' problems: (1) independent living, (2) fall risk (3) chronic disease, (4) dementia, (5) social isolation, (6) depression, (7) wellbeing, and (8) medication management (Figure 2).

The highest level of research attention was paid to wellbeing (with thirteen publications in the final set), which covers many aspects of positive functioning including happiness, life satisfaction and subjective wellbeing.

Independent living and Social isolation are the next two highest categories (with 9 and 8 publications, respectively). The majority of older adults want to continue living independently and technologies may enable them to stay in their own home longer before moving to nursing facilities. This preference is particularly facilitated by sensor technologies and robotics that can help seniors to live independently.

General ICT used to reduce social isolation and increase social connectedness. Studies report that the experience of social isolation in older people has increased and clearly has negative effects on older adults' health, wellbeing and quality of life [22, 23].

The next highest category is chronic disease (Seven publications). As population aging has accelerated, one of the challenges is dealing with chronic conditions. Innovative and cost-effective ways are required to meet the healthcare needs of older adults.



**Fig. 4.** Seniors' problems targeted by ICT researchers (and number of publications)

To monitor the elderly with chronic conditions in their own residence, telemedicine can be used as a cost-effective way to reduce unnecessary hospitalisation and to ensure that patients receive urgent care in a timely fashion.

Falls are a costly and unresolved safety issue for older adults and seniors who fall usually need medical attention. Researchers have tried to reduce the fall risk using technologies such as sensors and video games. Seven publications in the final pool dealt with fall risk.

Dementia is the next highest category of research on technology that provides benefits for older adults (with five publications in the final pool). The ageing population has led to a surge in the number of people with dementia. Dementia has implications for the individual's quality of daily life [24]. Seniors with dementia need suitable supportive living environments in which they can live safely.

Medication management is the next category (with three publications). Reminding older adults to take the right dosage of medicine at the right time especially those who suffer from chronic disease is very significant and has been one of the significant aids of technology for older adults [25].

Depression is the last category (with two publications in the final pool). The lack of communication and emotional support among older adults may result in depression. Technologies such as the internet may reduce depression by engaging seniors in social interaction.

### 3.3 Technologies used to assist seniors

We categorised the technological interventions reported in the 54 studies into six categories, namely, general ICT, robotics, telemedicine, sensor technology, medication management applications, and video games. Table 1 provides a summary showing which technologies were applied to address the eight categories of seniors' problems.

Robotics is a rapidly growing area of technology that provides services such as the operation of appliances and various other tasks that support the elderly's daily living. The main purpose of telemedicine is to provide specialist consultations to distant patients including diagnosing and treating through telecommunication devices [26]. Telemedicine is used in a more restrictive sense at home and involves the use of ICT to monitor the patient's status at a distance [26].

**Table 1.** Various assistive technologies proposed for seniors' issues

	Sensor Technology	Robotics	Telemedicine	ICT	Video games	Medication dispensing device
Fall risk	[27] [28] [29] [30] [31] [32]				[33]	
Independent living	[34-36] [37]	[38]	[39]			
Chronic disease			[40-42] [43] [44] [1] [45]			
Dementia	[46]			[47] [48]		
Social isolation		[49] [9] [50] [51]		[23] [22] [52] [53]		
Depression		[54]		[55]		
Wellbeing		[56] [57]	[60]	[61] [62]	[66]	

		[58] [59]		63] [64] [65] [12]	[67]	
Medication management				[68]		[69] [70]

Sensor technologies are designed to identify and alert caregivers and patients about critical events such as falling out of bed. The two goals that have lead to the fast development of various types of sensor technologies are independent living and fall prevention.

General ICT includes technologies such as using the computer and the internet. The selected studies focus on how the use of these successful technologies impacts on different aspects of senior life.

Seniors face the complex task of medication management, especially those with chronic disease. To enhance the accuracy of medication administration, medication management applications are designed through reminder services. These tools include medication dispensers and smart phone applications.

The last category is video games. The interactive nature of video gaming means that it can be used as a therapy tool and for relaxation and entertainment. Video games can improve the central processing speed and movement by brain training.

#### 4. Discussion

This study showed the importance of assistive technology uptake by older people and its positive impact not only on the individuals but also on those who work with them, including healthcare professionals, family members and the broader society. To encourage seniors and other stakeholders to accept and use new technologies, researchers and practitioners should promote the anticipated benefits such as independent living, increased safety, increased social connectedness and advances in mobility.

There is a need for medical researchers to be involved in ICT research projects to categorise the significant clinical benefits as well as the cost-effectiveness of using assistive technologies. Therefore, multidisciplinary research is needed to find and assess an approach to evaluating the impact of assistive technologies on older adults' daily life.

It is essential for ICT research to be based on theoretical frameworks and models to provide a justification for hypothesised relationships [71]. The lack of a theoretical approach prevents the researcher from following a systematic approach. However, few studies in this review were based on a theoretical framework. Therefore, future studies should develop a theoretical model that is specific to the context of aged care.

Most of the studies suffer from small sample size; therefore, future studies should use larger samples in order to validate the outcomes.

## 5. Implications for practice

The findings of this study provide a number of implications for practice by showing the benefits of assistive technologies. First, policy-makers and governments should financially support new technologies and increase ICT literacy among seniors. Therefore, governments should recognise and promote the use of new technologies and the positive impact of these technologies on society, healthcare and the quality of life among seniors. This is because the use of assistive technologies not only elevates the quality of the senior individual's life but also has a positive impact on the healthcare system overall by reducing costs, readmissions and the length of hospital stays. In addition, this study showed how assistive technologies offer various possibilities which could support seniors to live independently and have a better quality of life. Therefore, practitioners should integrate appropriate technologies and combinations of technologies based on older adults' needs either in their own residences or in nursing homes.

## 6. Conclusion

Assistive technologies are a reality and can be applied to improve quality of life, especially among older age groups. A combination of various assistive technologies provides promising results in supporting the elderly in daily life. By conducting a systematic literature review, this study identified various assistive technologies proposed by ICT researchers to assist the elderly. This review shows that, it is vital to develop systems and devices that suit seniors' needs and limitations with clear benefits.

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