Ambient assisted living technologies for older adults with cognitive and physical impairments: a review

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Abstract. – The global number of people over the age of 60 years is expected to increase from 970 million to 2.1 billion in 2050 and 3.1 billion in 2100. About 80% of the aging population will be in the developing countries. Aging population may suffer from various physical, cognitive, and social problems, due to aging process such as impairment of physical related functions (decreased mobility and walking speed, falls, frailty, decreased walking speed, difficulties in basic, and instrumental activities of daily living), cognitive related functions (memory-related issues), sensory functions (hearing loss, cataracts and refractive errors, presbyopia, decreased vestibular function), behavioural and psychological disorders, social isolation issues, and poor quality of life. Over the period of the last few decades, emerging technologies such as internet of things (IoT), artificial intelligence (AI), sensors, cloud computing, wireless communication technologies, and assistive robotics have given the vision to develop various ambient or active assisted living (AAL) approaches for supporting an elderly people to live safely and independently in their living environment and participate in their daily and community activities, as well as supporting them to maintain their physical, mental health, and quality of their life. The aim of this paper is to review the use of Ambient or Active Assisted Living for older adults with physical, cognitive impairments, and their social participation.

Key Words:
   Aging, Cognitive impairments, Ambient or Active Assisted Living, Ambient assisted living technologies, AAL, Older adults.

Introduction

Aging population with over 60 years old is expected to increase from 970 million to 2.1 billion in 2050 and 3.1 billion in 2100 all over the world[1]. By 2050, the aging population (65 years of age and older) is estimated 434 million, 170 million in Europe, 137 million in the USA, and 38 million in Africa, whose 80% of the people will be in the developing countries[2]. In Asian countries, the aging population is rapidly increasing, mainly in China due to one-child policy and reduced mortality rate[3]. With the rapid growth and development in medical and health care facilities, life expectancy has been increased worldwide, especially in the developed countries. Due to the increase in the population of aging, there are numerous problems arising in older adults, such as sensory changes (hearing loss, presbyopia, decreased vestibular function leads to falls), weakness of muscle strength and mass, sarcopenia, urologic diseases, immunosenescence, osteoporosis, cancer, osteoarthritis, diabetes, depression, chronic obstructive pulmonary diseases. In addition, changes in the physical and cognitive functions are very common in the older adults. For example, the elderly population will have difficulties in remembering the past events (memory loss)[4], and impairments in physical related functions, such as decreased walking speed, immobility, difficulties in performing basic, and instrumental activities of daily living[5,6]. The physical and

cognitive functions difficulties can be disruptive to individuals' sense of well-being, social interaction, and to their quality of life[7-9].

The National Institute on Aging (USA) reported that 85% of the aging population are living with at least one chronic disease, and 60% of the elders have at least two chronic diseases, and approximately 5.6 million of elder people are suffering from Alzheimer's disease or other types of dementia in the US. The total health care expenditure for the aging population in Australia is about AU$166 billion in 2015, and it will increase up to AU$320 billion in 2035. In the United States, the total costs were $414.3 billion in 2011[10], and about $290 billion dollars is estimated in 2019 for elderly people with Alzheimer's diseases[11]. Worldwide, the cost of caring for elder people with dementia was estimated to be $818 billion in 2015 that is equivalent to 1.1 percentages of global gross domestic product (GDP; World Health Organization, 2019). The responsibility of elder care is usually taken by family members, friends, caregivers, home nurses, or other health care professionals at home or in the residential care settings. In 2018, about $233.9 billion economic value of unpaid care was given by family members or relatives to the aged people with Alzheimer's or other dementia diseases in the US[11]. It has a significant impact not only on the elder people, but it also makes physical, mental, social, and economic impact on the family members, caregivers, and society. About 70% of the aging population is totally dependent, and they need assistance for their activities in daily living[12]. Over the period of last decades, the development of new innovative technologies, such as sensors, cloud computing, wireless communication technologies, and assistive robotics has given the vision to use the Ambient or Active Assisted Living (AAL), internet of things (IoT), artificial intelligence (AI), and approaches for supporting aging population. The Ambient or Active Assisted Living (AAL) technology has been developed to support the elder people to live safely and autonomously in their home environment, to participate in their daily life and community activities, and to maintain their physical and mental health, and quality of life. It also has a potential to reduce the informal health care costs and the burden to the families, caregivers, and society. However, there are very few studies which proposed the ambient assisted living technologies for older adults with cognitive and physical impairments in order to reduce the burden on families, care-

givers, and health care costs. This review paper aims at presenting a comprehensive overview of the Ambient or Active Assisted Living for older adults with physical, cognitive impairments and their social participation.

Association Between Physical, Cognitive and Social Participation and Activities of Daily Living

Physical Functioning and Activities of Daily Living

Successful or healthy aging has been determined by the following three factors such as higher physical and cognitive function, less probability of chronic diseases, and active participation in daily and social activities. However, the physical and cognitive health impairments and other age-related chronic diseases are inevitable in aging process[13]. Due to the physical and cognitive decline with increasing aging, older people are facing several limitations in the daily activities, such as difficulties in walking for long-distance, standing for long hours, kneeling, stooping, and bending postures[14,15]. Another limitation in physical and cognitive functions is the high risk of falling and difficulties in performing the basic activities of daily living (eating, dressing, bathing, toileting, functional mobility) and instrumental activities of daily living (managing medications, communication, transportation, shopping, and finances). Moreover, falls are one of the leading causes of injury, hospital admission, and death in elderly population. There are numerous factors causing risk of falling in elders, such as frailty, balance control, muscle weakness, impairments in vision, gait, and cognitive impairments, as well as depression[16-19]. Falls in older adults are also caused by various chronic diseases, such as diabetes, arthritis, and cardiovascular disease[20,21]. There are 3 million older people admitted each year in the hospital for fall-related injuries and there will be 7 deaths per hour by 2030 due to fall related injuries[22]. One of the previous studies reported that environmental hazards, such as poor lighting, bathrooms, slippery surfaces (81.7%) represented a reason for falling in older adults[23]. Deandrea et al[24] team reported that previous history of falls, use of walking aids, and disability had higher rate of risk of falling. On the other hand, some studies found that the falls are highly associated with cognitive functions, such as slow processing speed, verbal reasoning and ability,

poor executive function, attention, judgments and decision making[25-27], and in dementia patients[28-30]. There is two to three times more risks of falls for those having dementia than normal cognitive healthy person[31,32].

Cognitive Functioning and Daily Living Skills

Cognitive function, including memory, attention, sleeping, problem-solving activities, or speed processing, are playing a crucial role in everyone's independent daily life (managing finances, taking appropriate medications on time, and driving safely) and social life-effective interaction with others in terms of receiving, processing, and integrating the sensory information into appropriate response to the others, and these functions started to decline in the aging process[33-35]. Various medical condition drives to cognitive decline in the elderly population such as dementia, Alzheimer's disease, Huntington's disease, Pick's disease, supranuclear palsy, cerebellar degeneration, and stroke. However, dementia or in the form of Alzheimer's disease (AD) and Alzheimer's disease-related dementias (ADRD) are having a higher impact in making deterioration in cognitive function (control of behaviour, memory, attention, sleep, language and learning, intelligence, perception and visceral or sexual activities) and daily life functioning, social, and behavioural changes[36]. Indeed, Scafato et al[37] reported that 45% of the aged people (65 to 84 years) had declined cognitive function without dementia. In Alzheimer's disease, the cognitive deficits include short term memory loss, as well as with non-memory cognitive deficits, such as executive and visuospatial dysfunction, and praxis or language disturbance. Some predicting factors such as poor physical health, especially depressive disorder, diabetes, and cardiovascular disease, as well as poor education and socioeconomic status is also being associated with poor cognitive function and cognitive decline[38]. Millan-Calenti et al[39] reported that cognitive impairment and depression are correlated and coexisted in aging, as well as these both conditions are associated with limitation of activities of daily living and other chronic conditions.

Social Participation and Daily Living Skills

Social well-being of elderly is determined by their active social participation, as it is the key factor for active and healthy aging. There is no commonly accepted definition for social participation of elders in the existing literature. However, Janoski and Wilson[40] stated that social participation is including formal and informal group activities such as volunteering, communicating with families, friends, and others. Other authors[41,42] stated that older adults are performing their daily care activities themselves instead of taking care of them by family members, caregivers, and or health care professionals. On the other hand, researchers[43,44] reported that social participation can be defined as an involvement in the activities outside home such as work, community, voluntary, and social and leisure activities. It prevents the social isolation and reduces the risk of depression in the elderly people. However, in increasing aging factors, the aging people will have difficulties in developing new relationships with others, maintaining active social networks, and old relationships[45]. Tomioka et al[46] classified the social participation into five categories: neighbourhood associations, hobby groups, local event groups, senior citizen clubs, and volunteer groups. Ponce et al[47] emphasized the importance of social participation on aging population because the active social participation is associated with quality of life, well-being, and reduce the risk of morbidity and mortality, in particular, the cultural and organizational activities reduce the risk of mortality and institutionalization[48]. There are many factors associated with poor social participation, including socioeconomic status (age, gender, family income, and education status), and health status (decreased physical and functionality, low walking speed, loneliness and isolation, visual impairment, cognitive decline, depression). Goll et al[44] found that some behavioural factors have negative role in determining the active social participation, such as fears of social exploitation, fears of rejection by society or family members, and fears for losing their identity. Moreover, Vogelsang[49] reported that older people who live in the rural areas had lower social participation than urban areas, and the differences were observed in the social participation between the rural and urban areas, such as entertainment[50]. Likewise, the quality of life of elderly population in the urban areas had better score of Quality of life (QOL) than rural elderly population[50]. The lower social participation by non-institutionalised aging people have difficulty in performing activities of daily living (ADL) and instrumental activities of daily living (IADL)[51].

Ambient or Active Assisted Living Technologies for Older Adults

Assistive technologies are defined as equipment and services that are used to maintain or improve the physical and cognitive functions and enhance the overall well-being including the daily life of the aging and disabled population[2]. Another form of assistive technology based on ambient technology is called as an "Ambient Assistive Living Technology (AALT)". The AALT is an emerging assistive technology adapted with using artificial intelligence, information, communication, and networking technologies. It helps the aging population to live safely, actively, autonomously in the various environments and to participate in the social activities, such as home, neighbourhood, shopping mall, and various public places[52,53]. Based on the application of ambient, the assisted living technology can be classified into four categories, as for daily task facilitation, mobility assistance, healthcare and rehabilitation, and social inclusion and communication, or it can be supportive for home safety and social participation[54]. In our study we summarise the scenarios of ambient assistive living technology services into the following areas of application for elderly people with physical and cognitive impairments, and their social participation activities: (1) ambient assistive living technology tools for physical impairments, (2) ambient assistive living technology for cognitive impairments, (3) smart home technologies for physical and cognitive impairments, (4) ambient assistive living technology for social participation and reducing caregiver burden.

AAL for Physical Impairments

The basic activities of daily living skills (ADL) consist of the following activities, like eating, toileting, dressing, grooming, transferring bed/chair, walking, climbing stairs, and bathing[55], while the instrumental activities of daily living (IADL) are focusing with managing finances, shopping, food preparation, housekeeping, managing medication, using transportation, doing laundry, and ability to use the telephone. These activities of daily living skills (ADL) and the instrumental activities of daily living (IADL) in elderly can be evaluated through Modified Barthel Index[56] and instrumental activities of daily living[57].

With the development of advanced technologies in the areas of biomedical engineering, wireless communications, monitoring of human activities, are made feasible by a range of wearable sensors, such as accelerometers and gyroscopes. Number of non-wearable and wearable sensors have been recommended to support the elderly to perform their daily living activities in safe-home environment. The advantages of wearable sensors are being portable, weightless, low-cost, and suitable for supporting the elderly to do their self-care activities[58]. Demir et al[59] reported that the following sensors had been used to monitor and maintain safety in different daily living activities. For example, the kitchen (Reed Switch, Force Resistive Sensor (FSR) chair, LDR Light, Flame Sensor, Rain Sensor, Temperature Sensor), toilet (Reed Switch, LDR Light), bathroom (Reed Switch, LDR Light, PIR Motion Sensor), bedroom (Reed Switch, LDR Light, FSR). In this study, a force resistive sensor was used to confirm the position of the elderly while doing their eating activities, and to confirm the position of the patient in bed while sleeping. Several studies used wearable sensors to monitor daily activities, such as sitting, standing, walking, various positions of lying, running, climbing stairs, vacuuming, scrubbing. These activities were monitored by placing the sensors on waist[60-63]. On the other hand, Pirttikangas et al[64] used sensors on the wrists, thigh, and necklace to monitor the other instrumental daily living activities such as typing, watching TV, and the basic activities such as drinking, stairs climbing ascent, and descent.

Another important health issue among elders is falls, which make difficult to perform the daily activities in the home and community environment. Therefore, fall detection is one of the most important applications in the Ambient or Active Assisted Living system. Zhang et al[65] introduced a home-based AAL for fall detection, multimodality falls detection and telecare system, called "Home Healthcare Sentinel System (HONEY)". This system consists of multimodality signal sources, including an accelerometer sensor, video clips through speech recognition and on-demand video techniques, audio, and images. The results of this study found that the average response time for a detected fall was 46.2 second and 94% of the accuracy for fall detection. Yu et al[20] found that 97.08% fall detection rate was based on a computer vision-based fall detection system in a simulated home environment. Rucco et al[66] reviewed the literature for finding different types of sensors used for detecting fall and associated activities (standing, single-task walking,

dual-task walking, standing up, sitting, down, bending, daily activities, falling, running, sitting, lying, stairs activities). Most of the studies used the following types of sensors: accelerometer, gyroscope, pressure sensors, magnetometer, radar, time-of-flight (TOF) camera, kinect console, Wi-Fi console, electromyography, and infrared sensors. All sensors were placed in the trunk of the body parts because the trunk is the key point location for static and dynamic motions. Due to the development of advanced communication technologies, recently several researches were conducted using smartphone technologies to prevent the falls. For example, Casilari et al[67] team introduced a smart phone-based fall detection system (FDS), which contains 5 components, such as four nodes provided with inertial sensors (chest, waist, writs, and ankle) and a smartphone[67]. In this smartphone-based approach, the position of the sensor will play a crucial role to determine the effectiveness of the fall detection system. Especially the sensors that are located on the chest or trunk or waist are considered as good predictor of falls. Mauldin et al[68] used the combination of smartwatch with smartphone to detect falls. In this study, they used machine learning methods (traditional and non-traditional methods - deep learning) to create the fall detection models from the smartwatch, notch, and far-seeing datasets, and the results of their study showed the better performance in deep learning approach than traditional methods. This three-layer open IoT system can be adapted with other sensor modalities, such as, heart rate, skin temperature, walking patterns. The limitation of their study is that they used normal healthy volunteers to develop the fall detection model, which might have not provided real falls of elderly people. However, the smartwatch fall detection can be a low cost and portable device to use than other expensive fall detection system. Figure 1 shows an overview of AAL support system for different activities of daily living.

AAL for Cognitive Impairments

The daily functioning of the elderly at home is not only affected by physical impairments, but there are also other influencing factors for the limited functioning of the elderly population, namely cognitive impairments and wandering behaviour. People with cognitive impairments are hospitalized or institutionalized three times more than some other medical conditions[11]. The aging people with cognitive impairments will have difficulties in remembering, not recognising familiar places and people, will have trouble to take decision and poor judgement, and will repeat the same stories again and again, associated with other sensory impairment (vision and hearing) and behavioural issues (wandering). The most important problem of cognitive impairments in aging population is the deterioration of basic and instrumental activities of the daily living skills (BADL & IADL). Specifically, the IADL activities (managing finances, problem-solving, taking medication in a specific time, and house works) are mainly depending on the cognitive abilities or functions of the individuals. At the same time, BADL skills are associated with motor functions[69]. Moreover, depression, loneliness, and social isolation are commonly associated problems in older adults. Depression can also create more impact on complex activities, and basic functional performance in older adults[70]. In order to facilitate the independent living and improve the cognitive impaired people lives, various technological interventions have emerged in recent decades, including "low-tech" environmental adaptations. The recent advanced development in the areas of computing, internet of things, and sensing technologies made feasible way to solve the daily functional limitations problems in older adults.

In the previous literatures, wearable and non-wearable sensors have been recommended for monitoring ADL activities. Wearable sensors such as accelerometers, wristwatches, accelerometers with gyroscopes, wrist-worn unit sensor, and smartphones with multiple sensors have been used to monitor the various basic daily living or motion activities[71]. Non-wearable sensors, such as passive infrared (IR) sensors, are used for detecting motion or location, daily life activities, and sleeping conditions (total sleep time, number of sleep interruptions, and sleep rhythm) in dementia patients. The PIR sensors are also being used to monitor the activities of depressive patients, such as how long they are in inside the home and outside the home, as well as their sedentary and puttering activities[72]. A study found that the number of outings in the cognitive decline of the aging population was less than normal elderly people. However about more than 20 outings from home environment was noticed in the normal elderly people without cognitive decline problems. In addition, their indoor activities were also decreased in patients with cognitive decline[73]. There are other various
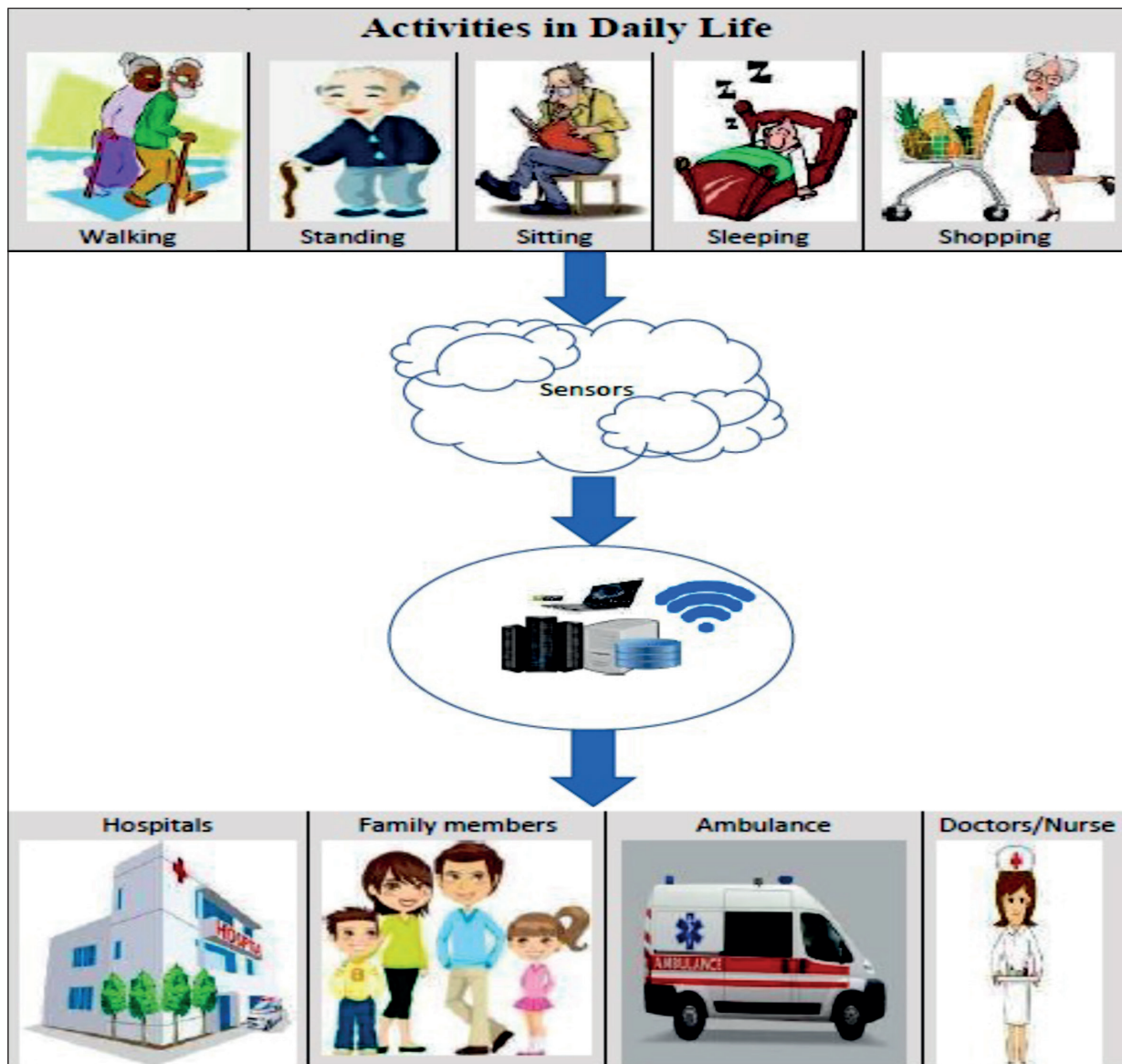
Figure 1. AAL for physical impairments

technologies which have been used for enhancing indoor activities for patients with cognitive decline, such as in-home monitoring system (IMS) for recording the behavioural patterns related to daily activities[74], and smart home sensors for detecting mobility, cognition, and mood changes in Alzheimer's Disease[75]. Rui et al[76] used radar sensor technology for gesture recognition, such as hand and head movements. Moreover, multiple types of ambient sensor technologies were used in some studies for monitoring ADL activities, falls, and home safety, including pressure sensors for detecting the existence of elder in the chair or bed, sound sensors for detecting noises at the kitchen, floor sensors for automatic controlling of switches, and mobile robots for independent daily life[77].

Another impairment of cognitive function in older adults is memory. The ambient assisted living technologies tools can be very useful for elderly with cognitive impairments, especially problems in memory. The idea of cognitive assistive devices dates to 1960s[78]. Previous researches have largely ignored the AAL technology to enhance the lives of elderly population with mild cognitive impairment. Therefore, this study has

also focused on reviewing the possible AAL technologies for people with cognitive impairment. AAL technologies can support the elderly population with cognitive impairments (time orientation, memory, and safety) through various reminders, such as digital pillboxes, digital calendars, electronic organizers for managing appointments, speaking watches, Global Positioning System (GPS), and tools for monitoring daily activities[54,79].

Wandering is one of the most dangerous problematic behaviours among aging individuals with dementia, associated with falling, elopement, getting lost, and emotional distress[80]. This is a major concern for family members, caregivers of dementia patients due to lost in somewhere alone or in familiar places or falling. Due to high prevalence of wandering and its negative outcomes, the management of this problem is more complex to prevent the wandering behaviour. Conventionally, the wandering behaviour is being treated by medications and physical restraining. These methods are creating some undesirable side effects physically or socially. There are many commercially available sensors or devices used to prevent a wandering behaviour by locating the position of wandering elder people with dementia such as Angel Sense, iTraq, GPS Smart Sole, Mindme, Pocket Finder, Project Lifesaver, Revolutionary Tracker, Safe Link, ankle-worn tracking device, and Trax (www.alzheimers.net). In addition, Lin et al[81] introduced an active infrared-based method to detect the wandering activities at the place of indoor, and their study found 98% of accuracy. AIR sensor is more reliable, cost effective, and easy to deploy, when compared with switch sensors, UWB sensors, step-count sensors, passive RFID, pressure sensors.

Smart Home Technologies for Physical and Cognitive Impairments

A smart home is a trending concept with integrated automated systems of e-health and assisted living technology to enable the elders to live in a comfortable environment without support of others. This system can also be used for assessing the cognitive and physical health of the elders at home. The smart home technologies are become viable to elders due to the advanced development of computing, sensing, and network technologies connected with a variety of everyday devices and systems, such as low-cost sensors, actuators, appliances, computers, and mobile phones. The smart home technologies can be implemented through a variety of wearable and non-wearable sensors, such as magnetic switch sensor for detecting and opening the doors and windows, temperature sensor for detecting the temperature of the ambient environment, detecting illuminance, and providing continuous data by photosensor ambient sensor, pressure pad sensor for providing continuous pressure measurement in any surface, water flow sensor for measuring the flow of water in showers or taps, infrared motion sensor for detecting the motion of elders, force sensor for detecting movement and falls, smoking sensor for detecting smoke in the home, and wearable biosensor to monitor the vital signs[77]. The smart home technologies are aimed to provide comfort, healthcare, and security. There are many smart home-health care technologies which have been proposed or designed for aging people to live in a safe environment with emergency help systems (unconsciousness, falls, stroke, myocardial infarction), monitoring vital signs (measurements of pulse, respiration, blood pressure), safety (automatic on/off lighting, strip and fall prevention, hazard detection), supporting social participation activities (phone calls, communication through videos, virtual participation in groups), and cognitive or sensory supports (reminder medication, lost key locator), and functional monitoring such as measurement of general activities, motion, meal intake, and intruder detection (security monitoring support)[82]. For example, there are several smart home projects that have been proposed to help the elderly people to live independently and in a safe environment, such as Smart Home for Elderly People (HOPE) which is funded by the European Community[83]. The HOPE project is mainly designed for elderly people with Alzheimer's disease and it helps to perform their daily activities by themselves and monitoring their health. Another project is called the HEREiAM system, which is developed with the Television (TV)-based platform to support the elderly people to participate in the daily needs, health care, shopping, and social life. QuietCare system is a type of location-based smart home system, which has been used in each room to identify the location of elders by using Passive Infra-Red (PIR) motion sensor[84]. They used a Nokia 6230 cheap mobile to locate the people in the existing smart home environments. Borelli et al[85] described their smart home project, Home Assistance Based on the Internet of Things for the Autonomy of Everybody (HABITAT), which has been proposed

to develop the smart devices to support the elder people in their home environments or in an old age home. The HABITAT smart home system is utilised with sensors and actuators for developing four types of smart objects, including wall light for indoor localization, armchair for sitting posture monitoring, belt for movement information, wall panel, and mobile devices as user interface. This method of user-centred design has the capabilities to support the elders with visibility, physical, cognitive, and or sensory disabilities. Other ambient assisted living smart home or ambient assisted living projects, such as TRON project by Japan, Easy Living project by Microsoft, CASAS Smart Home by Washington State University, Aware Home Research Initiative (AHRI) smart home project by Georgia Institute of Technology has been developed to support the elder people[86].

At the same time, Reeder et al[87] conducted the perception of older women on wearable and smart home activity sensors. The results of their study concluded that the wearable and smart home activity sensors are useful in the daily activities. However, older women perceived that wearable sensors were more useful than smart home sensors, due to the reason of having their high-level activities mostly outside of their living environment. On the other hand, Reeder et al[87] reported that the older adults identified the importance of the sensor data for monitoring their health status and early identification of illness. Furthermore, their study reported that visual displays sensor data from AAL home are very useful for family members and health care providers as using electronic health records. Based on this review, this study noticed that most of the researches are mainly focused on elder people with physical impairments than cognitive impairments.

AAL Tools for Social Participation and Reducing Caregiver Burden

Social participation plays a crucial role in improving the health of aging population, prevention of illness, and their quality of life. While social participation involves meeting friends, volunteering in the community services and leisure activities, social isolation has a poor social network, living alone, and feeling lonely. Cacioppo et al[88] reported that 10 to 50% of the older adults are facing loneliness. The poor social participation is associated with poor physical, mental health, and risk of increasing high morbidity and mortality rate. Generally, people used to chat with friends face to face, or *via* phone, email, and

or by social media, such as Facebook to interact with family members, and societies. However, it is difficult to carry out the social participation activities in the older adults especially associated with physical or cognitive impartments. In this scenario, AAL systems can deliver specific social functionalities, which consist of social gaming technologies, simplified electronic mailing, video telephoning, and digital picture frames. A smart home is not only helping to support the quality of life of elder people, but also reduces the burden of the caregiver or family members[89]. In a systematic review, Baker et al tried to explore the usefulness of advanced technologies to improve the social participation in older adults, and their study reported that most of the existing literatures are commonly using existing social networks, such as Facebook or LinkedIn, or touch screen technologies to improve the social engagement of older adults[90]. Some studies[91,92] reported that information communication technologies-based game would motivate the elders to participate in fun game activities. Doppler et al[93] team proposed a TV and tablet-based communication and entertainment platform for enhancing the older adults in social participation and this proposed system is called BRELOMATE. Five months of trial results of the BRELOMATE client system showed that each elder was online for 37 hours for over the period of 8 weeks. Although social and communication technologies provide more positive effects on improving social participation among elders, caregivers, family members and others, there will be negative consequences as well. For instance, there are several misleading information (pro-suicide websites) available in online and online discussion forums, which may lead the elders into suicide.

Conclusions

In this review, we have explored an association between physical, cognitive, and social participation skills with basic activities of daily living and instrumental activities of daily living skills in older adults. The current trends of ambient assisted living systems or ambient assisted technology for elderly populations were discussed, especially how ambient assisted technology alleviates the difficulties faced by elderly people with poor physical, cognitive, and social participation skills. Furthermore, we have discussed the role of different wearable and ambient

sensors and smart home technologies to enable elders to live independently in a safe environment. Although advanced technologies would be very useful in assisting the elderly population in supporting their daily life, there are many visible barriers existing in practical use. Based on our review on the existing literature, there are many barriers in using Innovative Assistive Technologies by elderly populations with cognitive impairments than physical impairments, such as very limited experience for elders in using advanced technologies, and a lack of motivation to participate in activities, due to physical or cognitive impairments. Overall, this study found that there is a lack of methodological or clinical investigations to prove the effectiveness of AAL support for the elders. Most of the AAL studies or technologies were mainly considered more on physical impairments related disabilities rather than cognitive disabilities. Furthermore, this review found that there was a lack of researches related to the caregiver burden and their stress for handling the elderly. Further research is needed to evaluate the clinical effectiveness of specific technological interventions in supporting the elderly population with physical, cognitive, and social impairments.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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