

# Assistive Technology to Promote Active Lifestyle among Elderly with Cognitive Impairment

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**Abstract.** Advancement of technological applications in the appropriate manner could certainly be very beneficial for diverse community, regardless of age. Older adults are typically associated with the deterioration of cognitive domain which might cause them to be diagnosed with the neurodegenerative diseases. Although there is no evident cure for these diseases, but its progressions can be delayed by maintaining an active lifestyle. This paper attempts to review and summarize recent research and developments of the potential use of technology as an aid or tool to encourage elderly with the cognitive impairment to live an independent active lifestyle. The retained performance of Activities of Daily Living (ADLs) is the key to an active lifestyle among elderly. The paper concludes with a brief discussion on the significant of technological application in assisting the elderly mainly with cognitive impairment to perform ADLs, as well as maintaining the good quality of life.

Keyword: Assistive technology, activities of daily living, active lifestyle, older adults, cognitive impairment

## 1 Introduction

Over the past decades, there are significant changes for both negative and positive impacts in politics, social, economic and legal spheres that open the vast opportunities for design and technological interventions to serve the community. This is indicated by the increase in awareness and knowledge on the importance of technology-related platforms to bridge the issues between the community levels and the possible solutions. Utilizing technology in the appropriate manner could certainly be very beneficial to every level of ages in these diverse communities. Even so, as users are often considered as the main consumers, users with special needs and unique incapability as well as the senior citizens have always been neglected in the major design decisions. The need to design with respect to older and disabled people should be further encouraged and addressed.

Ageing population is not uncommon; it exists in almost all the countries in the world. According to the report by the United Nations on World Population Ageing 2013 [1], the

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segment of older people aged 60 years or over has globally increased from 9.2 % in 1990 to 11.7 % in 2013. This rate will continue to grow as a proportion of the world population, reaching 21.1 % by 2050. In parallel, older adults are typically experiencing the age-related changes such as slower cognitive functions or cognitive decline. In fact, ageing is the greatest known risk factor for neuro-degenerative disease namely Dementia due to Alzheimer's disease (AD).

It is apparent that the decisions for the design mainstream and production of everyday products, systems or services should appropriately meet the necessities and inclusive of the disabilities shown by this group of population. This is due to the alarming statistics that the worldwide ageing of the population will more than triple the projected number of demented persons between 2010 and 2050 [2][3]. Although there are some indications the neuro-degenerative diseases may be decreasing, current data are scarce and inconclusive [4]. Also, cognitive impairment is an important cause of disability and dependence among older people.

With the advancement of technology in today's world for diverse applications, the ageing population could certainly benefit from it. But then again, the needs and issues manifested by this group of population should be comprehensively investigated in order to offer the probable ways to assist them. Thus, the key question raised in this paper is on how technological applications can be used for health promotion purposes among the elderly with cognitive impairment.

The recent study is at the stage of theoretical construct, where data of existing literature reviews and of the groundworks are collected and analysed. Whereas, there are many studies reported on the benefits of technological advancement in empowering humanity. This includes and not limited to the technology in assisting those disabled people in need. Accordingly, the paper attempts to review and summarize existing works on the potential use of technology as an assistive tool to encourage elderly with the cognitive impairment to live an independent active lifestyle.

In the light of worrying epidemic of demented population, therapeutic interventions and preventive approaches which lead to even slight delays on its onset and progression may reduce the global burden significantly, mainly due to the highly intensive care. Besides, expenditure and caregiving cost of this disease can be decreased all at once.

## **2 Needs of Alternative Interventions**

Cognitive degenerative disease may take up to more than 20 years for those surviving the final stages [5]. Older adults with severe cognitive impairment are weakened in terms of memory function capability, communication, voluntary motor skills and understanding of information. Sadly, these are all the very basic human necessity for well-being, self-worth, social interaction and autonomy [6]. It is certainly critical to ensure these basic and higher human needs are persevered to maintain the overall normal functioning and good quality of life.

Emergence of pressing needs caused by cognitive impairment deliver numerous chances for many forms of therapies. To date, there are worldwide efforts in finding better ways to treat the problem, delay its onset, and temporarily reduce its symptoms from worsening. Then again, although pharmacotherapy may possibly reduce its symptoms from rapidly evolving, many have agreed the current treatments cannot totally stop its progression. The constraints of current pharmacotherapy on the drugs' efficiency and availability provide the needs to promote more on nonpharmacological therapeutic intervention.

As a matter of fact, there is an increasing body of interest at present on non-pharmacological therapy (NPT) or non-drugs approach [7][8] being used for interventional

purposes. The available form of therapies ranges from physical therapies, musical intervention, animal-assisted intervention, and more design and technological approach like wearable technology, naturally-mapped environment, intelligent ambiance and so forth. Notwithstanding, the required information from the involved fields of interest should be primarily founded, so that the balance between theoretical and practical requirements can be initiated. Regarding this matter, there are many studies demonstrate the benefit of maintaining an active and healthy lifestyle towards the cognitive functions in general for the older adults. Yet, there is a dearth of findings and evidences on interventional strategies related to health promotion in elderly care, making the need to encourage more studies in this field undoubtedly worthwhile.

## **2.1 Benefits of Maintaining Active Lifestyle Among Elderly**

Many believe that maintaining an active lifestyle preserves physical and mental health in older adults. Although the connection between physical activities and the effect towards brain biology and function is still one of the most discussable topics among medical experts, high levels of physical activity are associated with reduced risks of cognitive impairments [9]. Studies of physical activity programmes for people with dementia have demonstrated either improvements in cognitive functions or slower decline in cognitive abilities [10]. In fact, it is one of the most promising protective factors towards cognitive decline in elderly persons.

Equally important, the brain continues to grow new cells or sometimes referred to as brain plasticity. We also know that the brain requires adequate blood flow to receive the oxygen and nutrients it needs to function well. So, performing a constant physical activity supports both these important aspects of brain biology [11]. Demonstrated benefits have also included conservation of Activities of Daily Living (ADL), improved physical fitness, and at the same time improved wellbeing.

On the other hand, the conservation of active lifestyle is also associated with social impact. Social aspect influences the cognitive function of older adults, where social isolation accelerates the progression of cognitive decline [12]. In term of social networks, many studies suggest the link to mortality. Persons with bad social engagement or socially isolated have increased up to four times the chance of mortality, while indirectly affecting their close community [13][14].

Though many studies reveal the benefit of maintaining an active and healthy lifestyle, the activities done by normal people are probably unsuitable for demented persons, since the decreasing in cognitive domain worsen most of the body functions. It is not easy to provide the appropriate care for individuals with this neurodegenerative illness, let alone to develop series of programs that are appreciated by them. One of the most challenging aspects of providing the appropriate care is to develop daily routines and activities that are stimulating, interesting, meaningful, and valued by these persons. Conceptualizing the intervention which include mixed activities with the access to social, physical, mental, and spiritual needs is a very challenging-yet-complex task to do.

Thanks to the new development in technological advancements which are likely to make important contributions to the care of older adults both at home or institutions. There are emerging new applications of technology to assist the elderly, basically in performing their ADLs. The goal of employing any form of assistive technology is to increase the independence and eventually the engagement towards social activities as well as delaying the institutionalization. Home care is often more economical than those provided at the institutions and usually preferable by both the elderly and the carers.

### **3 Technological Interventions for Health Promotion**

Health promotion is typically associated with personal lifestyles. The interventions intended for this purpose should ponder the self-determination and motivation by the targeted group. Having said that, the change of health-related behaviour is a long process, and it involves many factors especially when that person is so used with his/her sedentary habit [15]. The situation might become even more difficult for the elderly persons with disabilities.

Undoubtedly, at present there are many intervention strategies with the integration of both low and high technological applications premeditated to support the elderly care [16]. Electronic sensors, navigation or wayfinding devices, video monitoring and fall detector, just to name a few. Nonetheless, despite being practical to cater some common issues of the elderly, technological intervention that is specifically designed to promote their active lifestyle is unusual or insufficient. Besides, the conventional techniques used for normal or healthy persons are not fully adaptable for the elderly persons.

As previously discussed, physical activity is widely recognized as an important behavioural characteristic for health promotion and disease prevention, regardless of age and individual physical and mental capabilities. In the case of older adults with cognitive impairment, the appropriate supervision is certainly necessary, thus the intervention should be made clear to focus on their specific health-related problem.

Despite the emerging number of studies that proves the important role of physical activity, they are still cannot firmly assure able to convince most people to live an active lifestyle. This is because, people tend to practice things that are convenience to them and without having to be enforced. Recent technological advances in Internet of Things (IoT) for instance, can certainly be explored and tailored to support the pressing needs of health promotion among elderly [17]. Therefore, the following section provides the principal propositions of design and technological requirements in designing a technological intervention strategy meant for health promotion mainly among the elderly cognitive impairment. The review is narrative, where the selected studies are compared and summarized based on existing theories and models, while the results are made qualitatively.

#### **3.1 Remote Health Monitoring**

As the older adults with cognitive impairment are associated with the lack of autonomy to perform even the simplest daily task, we cannot expect them to accomplish the regular physical activities without assistance. Having a technological application that can monitor their health by means of enabling the data gathering and transfer could be of great use. The system may be equipped with sensors that collect vital variables of the users, for example body temperature, heart rate and user's cardiac conditions, which at the end will be transferred to remote device wirelessly [18].

Person's vital signs and parameters are a very crucial data that indicates the status of their health condition. Relating to the elderly with cognitive impairment who require great supervision, the transmitted health-related data can be monitored and examined by the carers as well as the medical experts. The device works to notify the carers to take the prompt action when there is an irregular condition emerges. This will help them to keep track of the patient's health condition more effectively.

In maintaining the active lifestyle via physical activities, additional features to remind them what to achieve on daily basis such as number of steps, amounts of calories to take and burn would be very useful. In addition, an accelerometer-based system that monitors the activity with embedded signal/feedback may result in the improved physical ability and rehabilitation [19].

The above-mentioned system and features are favourable in designing the digital health monitoring intervention for the elderly in various conditions. Moreover, since the therapeutic intervention is best to be implemented in the early stage of the disease, such system can be used even as an early diagnosis of medical condition [20]. Users and patients will get familiarized with this remote device, which indirectly not making them feel intrusive with its important features while at the same time allowing the regular health updates to the carers or medical experts. What is more important, this kind of technological intervention could reduce the intensive supervision and eventually maintain their good quality of life.

### **3.2 Injury Detector and Alert**

Due to the decline of physical ability, older adults are very likely to injure themselves. One of the most reported cases of injury among the elderly is caused by falling. It is in fact the leading cause of unintentional-injury death for elders 79 years and older [21]. However, the medical consequence of a fall mostly relies on how efficient the incident is managed, mostly on both response and rescue time.

For the elderly persons with cognitive impairment especially, who face both physical and psychological incapacities, the effective injury management is undeniably vital. This is because many who suffer from severe neurodegenerative diseases have the difficulties to communicate and show emotion apart from the decline in focus, reasoning and judgment [22]. A possible solution is to provide an effective and accurate system that can detect fall. The system which is designed to either be a standalone or embedded system is a highly significant element of a built environment meant for this group of people and will indirectly advance their medical care.

Issues on fall has become a topical subject of research when it comes to elderly care. Because of this, there is always a demand by the medical and healthcare industries for the technological interventions on fall detection systems or devices. Designing an effective fall detector and management system for the healthy people is not an easy task, let alone for the elderly with cognitive impairment. There is indeed an increase of awareness on its importance, where there are many kinds of fall detectors available at present. Nonetheless, not all of them work effectively especially for this group of people. The users may suffer from the unwanted consequences due to the badly design system, such as the device being intrusive, not user-friendly and system malfunction in the event of user noncompliance.

Fall may cause fractures and other serious injuries in elderly people, hence the proper planning on fall as well as injury prevention is very relevant. The preventative intervention can be achieved by targeting on effective strength and balance training programme. This kind of programme is expected to enhance the muscle strength, flexibility, balance, coordination, proprioception, reaction time, and gait in elderly people, which at the end reduce the future risk of injuries mainly caused by fall [23].

As much as the preventative approach, with the proper execution is likely to succeed, further studies are necessary to thoroughly investigate on how the programme influences the fall risks among the elderly people. The effect might as well diverse for different settings i.e. home or institutional. Even so, an important factor to consider is the inclusion of exercise in the programme. Frequency, duration, and intensity of physical activities or other form of exercise influence strength and balance. Therefore, based on this apparent reason, combining fall detector in the health monitoring system is totally practical. While the users/patients can maintain the active and healthy lifestyle, they can simultaneously reduce the potential of fall and consequently injuries, due to the increased of muscle strength and balance.

### **3.3 Digital Mental Exercise**

Countless advantages of maintaining an active lifestyle towards the cognitive functions for the older adults have been clearly justified earlier. Notwithstanding, active lifestyle intrinsically, does not only inclusive of preserving the physical activities but also the psychological functions. In reality, one of the most established factors that prevents age-related mental function deterioration among elderly is by keeping mentally active [24]. Thus, it is essential to deliberate activities or tasks that may stimulate the brain function as part of the intervention program for elderly.

The common techniques for brain stimulation principally for elderly with cognitive impairment is the mental exercises. Activities like games and puzzles, learning foreign languages, drawing mental map and creating word pictures are among many examples of mental exercises which aim to boost and preserve the memory functions. As been discussed by [25], the rate of cognitively age-related decline in older adults who are more mentally active is reduced or less apparent as compared to those who practice lower mental activities.

Again, with the abundance availability of technological applications nowadays, the mental exercises can be made more effective and engaging simultaneously. This is important specifically for this group of people who are known to face issues with concentrations. Even so, the said technological intervention should be designed and customized according to the notorious limitations of the targeted persons. Due to these limitations, the system must not neglect their disabilities while concurrently fully utilize the remaining abilities.

The integration of mental exercises in the whole parametric design of digital health monitoring system may become the daily training program meant for elderly persons, with or without cognitive and physical disabilities. The well-programmed and efficient physical activities that combines mental exercises contribute to the psychological benefits, mainly in the aspects of mood or emotional enhancement, positive self-construction/perspective, and stress reduction. In addition, the advantages of this integration may be extended to the individuals whom diagnosed with mental disturbance such as depressed or anxious. These positive improved aspects are essential in preserving the memory functions.

### **3.4 Device Wearability**

The needs for wearable form of devices have long been desired. Many of the devices designed to be wearable such as the invention of time pieces and eyeglasses, are for their obvious purposes i.e. accessibility and practicality. Only after the abundance of technological platforms is available today, the integration of data-input is featured for local data storing purposes. This way, wearable technology provides form for user communications and interaction capability, letting the wearer's access to information in real time.

Furthermore, technological advancement allows the existing devices to be scaled down or miniaturized into new improved forms that do not limit users' mobility but with maintained or better functionality. Amongst the most established examples of this scaling down or miniaturization evolution are the mobile phones, radios, and computers which are made more personalized and customizable. However, reducing the size of computing tools, for instance from the desktop computer to a smaller and portable dimension does not add much value to the existing one. In relation to this, designers and engineers should make the most of a whole new context of putting human physique as a framework to the proposed innovations or technologies.

Wearable devices have been used since the past decade and give a positive impact on healthcare and medicine, way before the current demands for other applications. A study by Park and Jayaraman [26] for instance, who reported on the basis of unobtrusively monitoring the patients' health and well-being. They presented "Wearable Motherboard™" designed in 2003, worn as a shirt, aimed at monitoring vital signs and sending that biofeedback information to a hub station in real time.

The practical aspect of wearable device is clearly appropriate to be employed in the context of designing the technological aid to monitor individual's health. Technically, health monitoring system in a wearable form could be a successful technological intervention needed by the elderly persons in promoting their active lifestyle. This is essentially due to the unobtrusive and practicality of the system.

One of the most important principles in designing the wearables is the comfort feature. As a matter of fact, people with cognitive impairment are known to experience the difficulty in dressing [27] and yet, comfort is the main goal within the care of this group of people [28]. Hence, it is imperative to design the wearable device to be easily put on and taken off. For the technological intervention that integrates the signal/feedback to the users, it is advisable place the wearables on the appropriately chosen body parts, as agreed by [29].

## **4 Reflection**

With the constant increased of global aging population each year, necessary actions should be taken to provide more possible solutions in assisting their needs, mainly in performing the daily activities. As ageing is linked with the decline of cognitive function, the solutions should in a way be potentially delaying the progression of cognitive degeneration. Making the full use of the available current technological applications as a medium to meet this goal provides limitless of possibilities. The previously discussed propositions of design and technological requirements demonstrates the attainable interventions to successfully accomplish the physically and mentally active elderly.

Introducing a new form of technological intervention is not an easy and straightforward task even for normal people. It should come along with continuous practices, constant uses, and proper training to get the users familiarized with the device system. The situation gets harder for cognitively impaired persons who have the difficulties to learn new and complicated things. But, the good thing is that the implicit memory i.e. unconsciously used and acquired memory in people with mild cognitive impairment is preserved. Hence, with the proper planning and execution, the health training program could give an important rehabilitative value to these people, only if it is habituated.

Another important point is the use of assistive technologies may be seen as an invasion of privacy by some people, although most people appreciate them [30]. Additionally, just like the people with disabilities, elderly with the degenerative diseases usually avoid being stigmatized in a way they are being noticeable as disabled. Using technological aids such as putting on a wearable device which make them look different from normal people, is the last thing they need. Therefore, even with most advanced technological aids, not everyone may enjoy and accept its benefits unless individual's limitation or incapacity has been carefully acknowledged. Besides, making the devices less obvious for these target users is crucial to avoid stigmatizing.

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