

Use of the Internet as a prevention tool against cognitive decline in normal aging

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Abstract: Recent demographic trends indicate that older people appear to be one of the fastest growing population groups worldwide. In the year 2000, people older than 65 years represented 12.4% of the population. This number is expected to rise to 19% by 2030, particularly in developed countries. Therefore, there is sustained effort at both national and international levels to prolong the active life of these people as long as possible. Since the present older generation at the age of 55 years is already digitally literate, the use of technologies is one of the solutions. The purpose of this study is to discuss the role of the Internet in the prevention of cognitive decline in normal aging. The author examines clinical studies that exploit the use of the Internet, including online training programs, in the prevention of cognitive decline in healthy older individuals. The findings of the clinical studies indicate that the use of the Internet, especially online cognitive training programs, may have a positive effect on the improvement of cognitive functions in healthy older adults. Nevertheless, larger sample longitudinal randomized controlled clinical trials aimed at the prevention of cognitive decline among healthy older adults are needed.

Keywords: healthy older individuals, Internet, prevention, cognitive functions, training

Introduction

The elderly appear to be one of the fastest growing population groups worldwide. Never before in human history has our planet included such a large percentage of old people. As late as 1930, America's older population numbered fewer than 7 million – only 5.4% of the population. In the year 2000, people older than 65 years represented 12.4% of the population and this number is expected to rise to 19% by 2030, particularly in developed countries.¹

Cognitive skills play an important role in older people's daily functioning, such as remembering appointments and driving. Unfortunately, some of these cognitive skills decline during the process of aging. In spite of the fact that cognitive aging varies among different individuals, there are some common features.² Research studies show that changes in the cognitive domain are based on crystallized and fluid intelligence.^{3–5} Crystallized intelligence is the ability to exploit acquired skills and knowledge such as formulation of general information, use of vocabulary, reading comprehension, analogs, and numerical reasoning. This ability is more or less stable and does not change with age. In fact, it can be even enhanced with advancing age at a rate of 0.02–0.003 SDs per year at the age of 60 years and 70 years.⁶ In contrast, fluid intelligence, which usually starts in middle age, significantly influences the cognitive functions because this intelligence requires speed processing, problem-solving skills, working memory, abstract reasoning, and learning.⁷ This ability usually declines at a rate of –0.02 per year

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and considerably affects older people's performance of daily activities and independent living.^{6,8}

In addition, there are a number of other aspects that can negatively influence cognitive functions in aging. These include sensory factors (eg, impaired vision or hearing), health-related factors (eg, pain or arthritis), changes in mood (eg, depression or anxiety), and drugs that can have side effects (eg, drowsiness).⁵ Thus, there is currently a general trend to delay these negative changes of cognitive decline by effective nonpharmacological approaches.⁹ Additionally, information and communication technologies (ICT) can be one of the noninvasive solutions to the prevention of cognitive decline in the process of normal aging. The use of technologies is also supported by three major current trends:

- an increase in the number of older people worldwide;
- ICT as a tool for providing older people with the promise of greater independence;
- the generation of "baby boomers" approaching retirement being relatively comfortable using ICT; they will bring many technology-related skills into their retirement years.¹⁰

In fact, the older generation is now much more digitally literate in the use of ICT than they were 2 decades ago.^{11,12} Heart and Kalderon¹³ stated that 80% of older people have fairly easy access to computers. Recent research studies also reveal that there is a significant increase in the use of ICT, especially the Internet, for health purposes.^{14–18} This concept of using the Internet to enable health care and improve health in the population is called e-Health.¹⁹ At present, e-Health shows big potential for older people because it can enable easier access to better and more effective health care. de Veer et al²⁰ reported that older people start to be open-minded toward the use of e-Health applications. Furthermore, Bujnowska-Fedak¹⁵ stated that although the main users of the Internet are young people, the key users of online health services are older adults. This is also confirmed by the Italian study¹⁷ and the German study¹⁸ in which more than a half of the seniors admitted using the Internet in search for health-related information. The Kaiser Family Foundation²¹ survey presented that older people use selected e-Health services that include, for example, obtaining information on their health, receiving reminders for scheduled visits, medication instructions, and consulting a doctor at a distance. Furthermore, they use Internet for researching health information about proper nutrition, exercise or weight issues, diseases, such as cancer, heart disease, and arthritis, high cholesterol, and health providers. Bujnowska-Fedak¹⁵ also added accessing and managing personal health records, participating in forums on

self-help groups focusing on health and illness, and ordering medicine and other medicinal products.

In addition, the Internet use may promote health literacy skills through providing opportunities for health knowledge acquisition, improving other cognitive functions such as reasoning skills, providing social benefits through social media and networking sites, and training the specific navigational and digital skills required to use the Internet.²²

Thus, the purpose of this study is to discuss the role of the Internet in the prevention of cognitive decline in normal aging. The author examines clinical studies that exploit the use of the Internet, including online training programs, in the prevention of cognitive decline in healthy older individuals.

Methods

The methodology of this review study is based on the study of Moher et al²³ and the study of Kurz and Baelen.²⁴ The main method was a systematic review whose aim was to find the research studies on the basis of the keywords in five databases: Web of Science, ScienceDirect, Springer, Scopus, and MEDLINE. This review was conducted in the period from 2010 to 2015 for the following keywords: "use of the Internet" AND "cognitive decline in normal aging". Altogether, 2,037 studies were found via the database search and 154 studies via other sources, which included conference proceedings and books outside the scope of the databases described earlier. After a thorough review of the titles, duplication, and abstracts of the selected studies, only 42 studies remained for the full-text analysis. After that, eight clinical studies were identified. The study was included if it matched the corresponding period, ie, from 2010 to 2015. The selection period starts with the year of 2010 since this is the year when the clinical trials conducted among older adults started to appear due to older individuals being more digitally literate and able to use the Internet on a daily basis.¹¹ Thus, the study was included if it matched the corresponding period, ie, from 2010 to 2015; if it involved healthy older people and focused on the use of the Internet, especially online training programs. The remaining selected theoretical articles, review articles, and book chapters were exploited in the discussion and in the introduction for the exploration of the research topic and comparison of findings.

Figure 1 illustrates the selection procedure of the final number of studies, which was done in the following four steps:

- identification (identification of the relevant studies on the basis of the keywords and, consequently, on the basis of the titles);
- duplication check (the same articles were included only once);

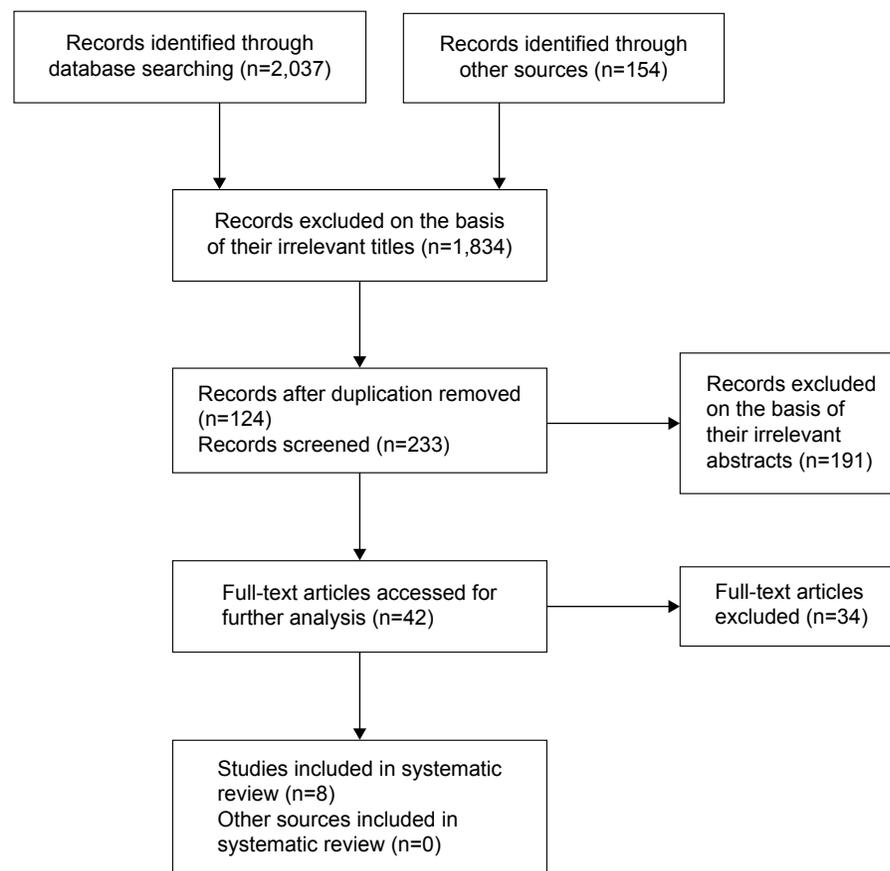


Figure 1 Results of the systematic review.

- assessment of relevancy (verification on the basis of abstracts whether the selected study corresponds to the set goal);
- after the exclusion of the irrelevant studies, 42 sources were analyzed and 34 eventually excluded.

Findings

Altogether, eight clinical studies focusing on the research topic were detected. The studies were included if the Internet/online intervention activities were involved and if participants were healthy older individuals (usually >60 years) although in two cases the intervention group also comprised subjects with mild cognitive impairment. The research studies had to cover the designated period from 2010 to 2015. In addition, they had to be written in English. Four of the clinical studies were randomized controlled trials, which means that the efficacy of the treatment of the intervention group could have been compared with the control group; two were longitudinal cohort studies, one was a randomized clinical study, and one was a pilot study. The efficacy of the intervention treatment in the studies was predominantly measured with available validated cognitive assessment tools such as a computerized

cognitive assessment battery. One of the most reliable tools is, for example, Brain Aging Monitor-Cognitive Assessment Battery.²⁵ As far as the intervention tool is concerned, five of the clinical studies focused on online cognitive training programs, one on the Internet-based conversation, one on the use of the Internet/email, and one on the use of computers. Table 1 provides an overview and the main findings of these eight studies.

Discussion

The findings of the clinical studies described earlier show that the use of the Internet, mediating access to email, online activities such as email and cognitive training programs, with one exception, has a positive effect on the improvement of cognitive functions in healthy older adults. The findings of the study by Xavier et al²⁶ indicated that the Internet enhances brain and cognitive reserve or leads to the engagement of more efficient cognitive networks, which may delay cognitive decline. This statement has been confirmed by other studies explored in Table 1, ie, the study of Almeida et al²⁷ and that of Dodge et al.²⁸ Almeida et al,²⁷ for example, argued that the use of computers, including

Table 1 An overview of clinical studies focusing on the Internet and its role in the prevention of cognitive decline in healthy older adults

Study	Objective	Number of subjects	Period of intervention	Type of intervention	Findings
Almeida et al ²⁷ (CS)	To determine if older men who use computers have lower risk of developing dementia	5,506 Australian men aged 69–87 years	8.5 years	Use of computers, as well as emails, the Internet, word processors, and games	The results indicated that the risk of incident dementia is ~30%–40% lower among elderly computer users than nonusers. In addition, these results cannot be attributed to age, education, social isolation, depression, poor physical health, or prevalent cognitive impairment
Bozoki et al ³³ (RCT ^a)	To test the hypothesis that seniors aged 60–80 years can improve key aspects of cognitive ability with the aid of such games	60 older subjects (age 60–80 years); two intervention groups, no control group	6 weeks	Online cognitive training program	The findings showed no transference effects; the effect of size on cognition was relatively small; only improvements on games. Nevertheless, longer interventions or more intense games might significantly enhance cognitive functions
Corbett et al ³⁰ (RCT)	To assess the effect of the computerized training program on cognitive functions	2,192 older subjects; mean age 65 years; three groups: general CT, reasoning CT, and control	6 months	Online cognitive training program	The results indicate that general and reasoning packages gave benefit to IADL ($P=0.008$, $P=0.011$), reasoning ($P<0.0001$, $P<0.0001$), and VL ($P=0.007$, $P=0.008$) at 6 months; benefit in reasoning was evident from 6 weeks. The decline is age sensitive
Dodge et al ²⁸ (RCT)	To assess whether conversation-based cognitive stimulation, through personal computers, webcams, and a user-friendly interactive Internet interface had high adherence and a positive effect on cognitive functions among older adults without dementia	83 subjects participated (intervention: $n=41$, control: $n=42$); their mean age was 80.5 (6.8) years	6 weeks; daily 30-minute interactions	Internet-based conversation	The findings revealed that healthy older individuals had improved on a semantic fluency test ($P=0.003$) at the posttrial assessment and a phonemic fluency test ($P=0.004$) at the 18-week assessments. Among those with MCI, there was an improvement in their psychomotor speed
McAvinue et al ³³ (RCT)	To evaluate the efficacy of a working memory training scheme in improving memory in a group of older adults	36 healthy older subjects (age 64–79 years); 19 in the trainee group and 17 in the control group	A 5-week training period + a 6-month follow-up	Online cognitive training program	The findings show that the trainees improved far more than the controls from the pretraining to the posttraining assessment, $F(1, 33)=10.35$, $P=0.003$, $\eta^2=0.24$, which was maintained at the 3-month follow-up. The results proved enhanced short-term memory, together with transfer of training gains to long-term episodic memory tasks
Vermeij et al ³¹ (PS)	To explore the transfer effects of core working memory training on the working memory domain and other cognitive domains	23 healthy older subjects (mean age 70.2±5.4 years); 18 MCI subjects (mean age 67.1±6.5 years)	25 training sessions (each 45 minutes) + a 3-month follow-up period	Online cognitive training program	The results proved that both groups had improved on the Digit Span and Spatial Span. In addition, there were gains on trained and untrained tasks within the WM domain, but no broad generalization to other cognitive domains
Walton et al ³² (RCT)	To assess the effectiveness of online cognitive training program on the improvement of cognitive performance in healthy older adults	28 healthy older subjects (mean age 64.18 years); one cognitive trainee group and one active control group	28 days	Online cognitive training program	The results revealed that spatial working memory showed significant improvements in accuracy and measurable improvements in nonpracticed outcome measures in healthy older adults
Xavier et al ²⁶ (CS)	To investigate whether digital literacy might be associated with decreased cognitive decline in older adulthood	6,442 participants aged 50–89 years	8 years	Internet/email use	Digital literacy may help reduce cognitive decline among persons aged between 50 years and 89 years

Note: ^aNo control group.**Abbreviations:** CS, cohort study; CT, cognitive training; IADL, instrumental activities of daily living; MCI, mild cognitive impairment; OS, observational study; PS, pilot study; RCT, randomized controlled trial; VL, verbal learning; WM, working memory.

emails, the Internet, word processors, and games, may serve as an appropriate intervention tool against the development of dementia. As this study proved, the risk of incident of dementia was ~30%–40% lower among elderly computer users than nonusers. This is in compliance with another research study by Tun and Lachman,²⁹ who reported that the use of computers has been connected with enhanced cognitive functioning in adulthood and old age. In addition, the reviewed study by Xavier et al²⁶ claimed that the use of the Internet, ie, digital literacy, may have a positive impact on healthy behaviors such as physical activities, higher consumption of fruits and vegetable, and less smoking among older individuals.

Moreover, the intervention of online cognitive training programs presented in Table 1, which can be done, thanks to the Internet access and digital literacy of older adults, may also contribute to the improvement of certain cognitive functions. The findings demonstrate the enhancement especially in the area of reasoning skills and short-term memory with transfer effects on nonpracticed tasks.^{30–32} However, the findings of the most of the reviewed clinical studies in Table 1 illustrate that the samples of the subjects using the Internet, especially doing online based activities, are relatively small and the intervention period is short. Therefore, larger sample longitudinal randomized controlled clinical trials aimed at the use of the Internet in the prevention of cognitive decline among healthy older adults are needed. This conclusion is also supported by other reviewed studies such as those of Bozoki et al,³³ Haesner et al,³⁴ and Lampit et al,³⁵ who believe that longer and more intense interventions might significantly enhance cognitive functions.

Moreover, research studies conducted in the area of the prevention of cognitive decline include other noninvasive intervention approaches such as physical activities, adherence to the Mediterranean diet, Chinese herbal medicine, playing a musical instrument, and learning a new foreign language.^{36–44} Most preferably, these activities, including the use of the computer, ie, the Internet, should be done simultaneously. Anderson-Hanley et al⁴⁵ stated that there is a much bigger potential for the delay of cognitive decline if, for example, cognitive and physical exercises are performed at the same time. They can also have positive effects on psychic problems such as mood improvement, removal of agitation or anxiety, and strengthening of overall fitness.^{46,47}

Conclusion

The findings of the reviewed research studies suggest that the use of the Internet, especially online cognitive training

programs, might have a positive effect on the improvement of cognitive functions in healthy older adults. In addition, the use of the Internet, including online cognitive training programs, seems to be beneficial in several ways: it is a noninvasive, in many cases, personalized intervention, and cost-effective in the sense of widespread dissemination and reduction of administration and treatment costs.^{48–50} Nevertheless, more randomized controlled clinical trials should be conducted to establish conclusive efficacy of these intervention approaches such as the use of the Internet and online cognitive training programs in the prevention and delay of cognitive decline among healthy older individuals.

The limitations of this review study consist in the lack of available clinical studies on the research issue and different methodologies of the included publications. This might result in the overestimated effects of the use of the Internet in the prevention of cognitive decline, which can consequently have a negative impact on the validity of these reviewed studies.^{51,52}

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Disclosure

The authors report no conflicts of interest in this work.

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