



Cognitive Aging: Non-Pharmacological Interventions

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According to the literature, physical inactivity and lack of stimulating leisure activity are significantly important modifiable factors for cognitive aging. In this perspective article, we have summarized recent findings of non-pharmacological intervention effects on cognitive decline/dementia and have suggested that playing newly developed active video games, which can simultaneously increase both leisure-time physical activity and cognitively stimulating leisure activity, may be a good preventive measure against cognitive aging among the elderly. Public health interventions to promote lifelong leisure-time physical activity, using advanced active video games (e.g., safe, pleasant, free-to-play, and cognitively stimulating smartphone games which can promote not only leisure activity but also physical activity), could have the potential to decrease personal and social burdens associated with cognitive decline/dementia in old age.

Key words: aging, cognition, dementia, interventions, perspective

Cognitive aging is characterized by a gradual age-related deterioration in brain function, which leads to an increased risk of dementia among elderly people. Dementia, a clinical syndrome, is defined as the loss of brain capacity severe enough to interfere with daily functioning. Neuropathological changes in Alzheimer's disease (AD) and vascular dementia, the two main causes of dementia in older adults, occur with age and dementia prevalence is rapidly increasing due to the aging of populations worldwide. Non-modifiable factors (age and genetic risk factors) and modifiable factors (lifestyle and environmental risk factors) contribute to dementia in old age. In the absence of curative treatments for dementia, it is crucial to develop non-pharmacological interventions that will slow down cognitive decline before the onset of dementia.

Population-based community studies or survey data in the US, Rotterdam in the Netherlands, Stockholm in Sweden, and England have demon-

strated that age-specific prevalence or incidence rates of cognitive impairment and dementia decreased among people born later in the first half of the 20th century¹⁾. The improvements were attributed to favorable changes in modifiable factors (higher education levels, healthier lifestyle, and better control of vascular risk factors), suggesting that we could prevent cognitive impairment in later life by non-pharmacological interventions. In fact, in the Finnish Geriatric Intervention Study to Prevent Cognitive Impairment and Disability (FINGER: the first large-scale, longer-term randomized controlled trial to assess a multidomain approach for reducing the risk of cognitive decline), improvement in overall cognition after 2 years, which was measured through comprehensive neuropsychological test battery (NTB) total Z score, was 25% higher in the intervention group than in the control group; both groups improved in global cognition and the mean change in NTB total Z score was 0.20 in the

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intervention (diet, exercise, cognitive training, and vascular risk monitoring) group and was 0.16 in the control (general health advice) group²⁾. Although the extent of the beneficial effect in the FINGER trial was relatively small, it should be noted that even a small reduction in the incidence of cognitive decline/dementia is likely to have a substantial effect on its prevalence and associated public health burden. In an analysis of population-based data, Norton and colleagues examined relative contributions of seven potentially modifiable risk factors (diabetes mellitus, hypertension, obesity, physical inactivity, depression, smoking, and low educational attainment) to AD³⁾. This study indicated that the three most important population-attributable risks of AD worldwide were low educational attainment, smoking, and physical inactivity. The contribution of low educational attainment was not as pronounced in the US, Europe, and the UK and the largest proportion of AD cases was attributed to physical inactivity in these developed regions.

There is growing evidence that participation in leisure activities appears to be associated with a reduced risk of late-life cognitive impairment and dementia⁴⁾⁻⁹⁾. In a French cohort study over a 4-year follow-up period, leisure activities were assessed in individuals, aged 65 and over, without prevalent dementia at baseline⁶⁾. This study has shown that stimulating leisure activities (doing crossword puzzles, playing cards, participating in organizations, going to the cinema/theatre, and practicing an artistic activity) were significantly associated with a reduced risk of dementia. The findings in this study suggest that the promotion of cognitively stimulating leisure activities in elderly community-dwelling populations seems to constitute a prevention strategy which could delay dementia onset. It is a lot of fun participating in stimulating leisure activities, such as board games and video games, and these activities are more likely to be sustained over time^{4) 7) 10)}. Playing a custom-designed video game (NeuroRacer) involved participants performing a perceptual discrimination task while simultaneously performing a visuomotor tracking task¹⁰⁾. Multitasking performance across the adult lifespan, as assessed with this game, declined linearly from 20 to 79 years of age. However, following 12 hours of training, a

multitasking training group (but not a single task training group) demonstrated enhanced performance in elderly adults. This NeuroRacer investigation offers evidence of positive effects from video game training on cognitive control abilities that are known to be impaired in aging. Players of a somewhat similar game (Pokémon Go: a recently developed smartphone game) are tasked with walking around to find and catch 'Pokémon' by pointing their phone cameras and simultaneously tossing 'Pokéballs' with their fingers¹¹⁾. Pokémon Go can increase outdoor activity and social interaction. In this augmented reality game, players (spanning all ages) are usually required to walk 2-10 km to earn awards; substantial walking is known to have a good effect on the metabolic syndrome. A prospective study, using data from the UK National Child Development Study, revealed a significant relationship between cumulative leisure-time physical activity and cognitive functioning outcomes at 50 years of age⁸⁾. This cohort-based investigation and other studies have suggested that cognitive functioning in middle and old age could benefit from participation in leisure-time physical activity^{5) 8) 9)}.

Given that dementia is a multi-factorial disorder, an intervention that can modify several risk factors at the same time should be better able to obtain the optimal preventive effect. As described above, in addition to low educational attainment and smoking, physical inactivity and lack of stimulating leisure activity are also significantly important modifiable factors for cognitive decline/dementia; other major risk factors, namely, hypertension, diabetes, obesity, and hypercholesterolemia constitute the metabolic syndrome and these vascular risk factors are closely related to physical inactivity. These findings suggest that playing advanced active video (smartphone) games, which increase both leisure-time physical activity and cognitively stimulating leisure activity, may be a good preventive measure against dementia onset. There is a possibility that, through higher education levels (which can facilitate healthier lifestyle, including a non-smoking environment) and future development of well-designed cognitively stimulating active video games (which can increase leisure and physical activities throughout life), we could slow down cognitive aging among elderly people.

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