## Benefits of Badminton for Preventing Cognitive Decline and Dementia

## Subjects: Clinical Neurology

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Badminton is one of the most popular racket sports played by all age groups worldwide. Anyone can practice and play badminton as a leisure or competitive sport, regardless of age, experience, or skill level. It does not require physical contact among players or expensive equipment. Compared with closed-skill exercises (e.g., running and swimming), open-skill exercises (e.g., badminton and table tennis) have been reported to significantly improve cognitive function and prevent cognitive decline. This mini review aimed to investigate the findings related to badminton intervention for cognitive function, with attention to the modifiable risk factors of dementia in adults. Additionally, we outlined the characteristics of badminton's physical demands. This narrative review encompassed studies reported from 2013 to 2023 from multiple databases, including PubMed and Google Scholar. Keywords such as "badminton", "dementia", "cognitive function", "physical activity", and "depression" were used to identify relevant articles. Various studies, including randomized controlled trials, cohort studies, and case-control studies, were selected to provide a comprehensive overview of badminton intervention. Quantitative data analysis suggests that at a cognitive level, high-intensity badminton can enhance cognitive function with at least 10 min of play once weekly or 20 min of play once weekly on average, whereas moderate-intensity badminton can be effective when played for at least 30 min once weekly or 35 min twice weekly on average. For modifiable risk factors, recreational badminton for about 3 h weekly could effectively manage blood pressure. For body fat percentage and fasting serum glucose levels, recreational badminton for about 10 h weekly exerted positive effects. For depressive states, a moderate-intensity badminton program for 100 min weekly was effective. For lipid profiles associated with dementia occurrence, prolonged badminton intervention for more than 3 months may be beneficial. The characteristics presented here indicate that intervention with regular badminton exercise could effectively improve cognitive function and prevent cognitive decline in older adults.

physical activity open-skill sports racket sports cognitive function

preventive intervention non-pharmacological intervention

Badminton is a racket sport that is one of the most popular sports, known for its mass appeal in fitness and entertainment worldwide <sup>[1][2][3]</sup>. Competitive badminton is the fastest racket sport in terms of shuttlecock velocity, reaching speeds as high as 426 km/h. It demands agility, endurance, technique, psychological stability, physical fitness, and visuomotor integration <sup>[1][4][5]</sup>.

The world population is rapidly growing and reached 7 billion in 2012, with 562 million (8%) individuals aged  $\geq$ 65 years. In 2015, the number of older people increased by 55 million (8.5% of the total population). The older population is estimated to reach approximately 1.6 billion from 2025 to 2050 <sup>[6]</sup>. Currently, approximately 55 million

individuals experience dementia, and this number is predicted to increase to 78 million by 2030 and 139 million by 2050 <sup>[Z]</sup>.

There are 12 modifiable risk factors for preventing and intervening with dementia, including physical inactivity, obesity, depression, social isolation, diabetes, hypertension, head injury, smoking, air pollution, alcohol use, hearing loss, and low educational level <sup>[8]</sup>. While many studies have focused on the technical and tactical aspects <sup>[2][9][10][11][12][13]</sup>, a recent systematic review suggested that playing badminton improves overall health across all age groups, from children to older adults <sup>[14]</sup>. Previous studies have reported the benefits of badminton for physical, social, and psychological health <sup>[14][15][16][17]</sup>. Regarding physical health, several studies and a review demonstrated the effects of badminton on cardiac and respiratory functions, including increasing maximal oxygen uptake (VO<sub>2</sub>max) and bone mineral density, decreasing asthma, lowering risk of coronary heart disease, and improving body shape and physical abilities (e.g., speed, flexibility, endurance, strength, vertical jump, muscle coordination, manipulation, and motor skills). Regarding social health, badminton positively impacts social relationships, personal development, mood regulation, and intrinsic motivation, while also providing psychological benefits such as improved cognitive function, alertness, concentration, attention, depressive symptoms, and general motivation <sup>[14][16][17]</sup>.

Regarding the results of these studies on modifiable risk factors for dementia, badminton helps manage hypertension <sup>[16]</sup>. Midlife hypertension is associated with decreased brain volumes and increased white matter hyperintensity volume <sup>[8]</sup>. Badminton may reduce social isolation and physical inactivity by exerting its positive effects on social relationships and intrinsic motivation. Social contact, recognized as a protective factor, enhances cognitive maintenance and encourages beneficial actions, whereas isolation can be a prodromal symptom of dementia and depression <sup>[8]</sup>. Regarding physical inactivity, engaging in moderate-to-vigorous physical activity at least weekly for 25 years, or >2.5 h weekly for  $\geq$ 10 years, reduces the risk of dementia <sup>[8]</sup>. While badminton intervention improved depressive states <sup>[17]</sup>, whether antidepressants reduce the risk of dementia remains an open question <sup>[8]</sup>. Moreover, severe head injury is associated with extensive hyperphosphorylated tau pathology <sup>[8]</sup>. Badminton exercise may reduce the risk of head injury from falls via its positive effects on muscle strength, endurance, flexibility, and other physical abilities. On the contrary, while dyslipidemia is a well-known risk factor for atherosclerotic cardiovascular disease <sup>[18]</sup>, it may not be a direct risk factor for dementia. However, better cardiovascular health is related to a lower risk of dementia <sup>[8]</sup>. Badminton has been reported to be more associated with high-density lipoprotein (HDL) cholesterol levels than other aerobic exercises <sup>[19]</sup>. Thus, badminton is likely to be effective for dementia prevention due to its impact on improving modifiable risk factors.

A previous review <sup>[20]</sup> and a meta-analysis <sup>[21]</sup> indicated that physical activity is potentially effective for dementia, including cognitive function improvement. Aerobic physical activity for 6 months has shown benefits in functional ability in early Alzheimer's disease, proving superior to stretching and toning exercises <sup>[22]</sup>. A systematic review demonstrated that open-skill exercise (OSE) has greater cognitive benefits than closed-skill exercise (CSE), leading to significant improvements in cognitive function in children and older adults <sup>[23]</sup>. A meta-analysis <sup>[24]</sup> and a systematic review <sup>[25]</sup> indicated that regardless of baseline age, OSE positively affects executive function, including inhibitory control and cognitive flexibility, compared to CSE. Another recent review reported that aerobic physical

activities prevent cognitive decline and dementia and that OSE, including badminton, protects cognitive function more effectively compared to CSE <sup>[15]</sup>. Additionally, the cognitive benefits of table tennis, an OSE involving aerobic physical activity, were suggested to elicit changes in neuroplasticity in multiple brain networks underlying cognitive aspects, potentially preventing cognitive decline and dementia <sup>[7]</sup>.

A badminton intervention program improved executive function in adults with mild intellectual disability <sup>[26]</sup>. A study using magnetic resonance imaging (MRI) and functional MRI (fMRI) in professional badminton players demonstrated that badminton training and practice are associated with increased gray matter concentration in the cerebellum and functional alterations in fronto-parietal connectivity <sup>[27]</sup>. These alterations may promote visuospatial integration in badminton players <sup>[5][27]</sup>. In healthy older adults, acute badminton or bicycling interventions increased neurotrophic factors and myokines, and chronic OSE, including badminton, significantly increased the brain-derived neurotrophic factor (BDNF), supporting the effectiveness of chronic OSE training in improving functional integrity <sup>[28]</sup>. Furthermore, a recent functional near-infrared spectroscopy (fNIRS) study showed that a single session of badminton induced neural efficiency in the prefrontal cortex without increasing brain activation compared to running in young adults <sup>[29]</sup>. Thus, badminton exerts positive effects on several aspects of cognitive function.

Therefore, to investigate the findings regarding badminton interventions for the prevention of cognitive decline and dementia, this mini review focused on the effects of badminton intervention on cognitive function in adults, particularly examining modifiable risk factors such as physical activity and depression, which are crucial risk factors for dementia <sup>[30]</sup>. Additionally, we outline the characteristics and aspects of badminton's physical demands.

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