The Role of Physical Exercise in Cognitive Function

Michael Schwenk, PhD, University of Arizona Interdisciplinary Consortium on Advanced Motion Performance (iCAMP) and Arizona Center on Aging, and Jane Mohler PhD, MSN, NP-c, University of Arizona Center of Aging

The fear of memory loss leading to Alzheimer’s disease (AD) is a great concern of older Americans, yet to date there has been no effective method of prevention and few effective treatments for AD. Recent and accumulating evidence demonstrates that it is not just the body that benefits from exercise, but the brain, too. Although there is no current evidence that regular physical exercise can actually prevent AD, several prospective observational studies have found that physically active older adults may be less prone to cognitive decline and have a lower prevalence of AD than those who are sedentary. The physical benefits of regular aerobic exercise, including reducing the risk of cardiovascular disease and diabetes, strengthening the bones and muscles, and reducing stress, are well known. The benefits of aerobic exercise on cognitive function are less well known, but may include improved executive function (the ability to think abstractly and to plan, initiate, sequence, and monitor), multi-tasking, task switching, selective attention, and working memory, along with an increase in the volume of brain structures important for memory.

Exercise and Cognitive Impairment

Aerobic exercise can improve memory, reasoning, judgment and thinking skills for older adults with mild cognitive impairment (MCI). A 2013 study from the University of Maryland School of Public Health showed that an exercise intervention in older adults ages 60-88) with MCI (improved memory recall and brain function as measured by functional MRI (fMRI) neuroimaging. After just 12 weeks of a moderate exercise program, subjects improved their neural efficiency -- using fewer neural resources to perform memory tasks, compared to baseline. A 2012 study at University of California Irvine study showed a single 6-minute interval of moderately intense exercise improved memory in individuals with memory deficits, an effect postulated to be related to the exercise-related release of norepinephrine, known to play a role in memory modulation.

In particular, executive functioning seems to be susceptible to improvements induced by physical activity, implying a specific exercise effect on higher cognition rather than on other basic cognitive domains. Indeed, there is emerging evidence that executive function is the critical “cognitive component” that is important when facing real life mobility tasks that are complex and challenging. The strongest exercise effects on executive function have been noted for combined aerobic exercise and strength training and for more intensive exercise. Dual-task studies indicate that both attention and control of executive functions can be improved when performing a cognitive and a motor task simultaneously (e.g., walking while counting backwards), even in patients with early to moderate dementia. Recent evidence also points to dancing as a “natural” intervention combining exercise and cognitive challenge. However, specific recommendations for optimal dual tasking exercise regimens are lacking and further studies are required.

Research has demonstrated that even acutely impaired geriatric inpatients with dementia are able to carry out and benefit from some forms of exercise, dispelling the often held view that they are unable to participate in rehabilitation programs.

The bottom line is that exercise may have a preventive and ameliorating effect on cognitive decline (in addition to helping to maintain strength, balance, and flexibility). Regardless of the fitness level, most older adults can likely benefit from, and may well be able to perform, some sort of exercise regimen.

TIPS FOR DEALING WITH PHYSICAL ACTIVITY AS AN APPROACH TO IMPROVE COGNITIVE FUNCTION

- Recommend that all older adults participate in regular physical activity.
- For those who are physically fit, recommend at least 150 minutes per week of moderate-intensity activity, 75 minutes of vigorous intensity activity, or a combination of the two.
- For those who lack sufficient fitness for moderate- or vigorous-intensity activity, recommend activities of which they are capable. The goal is to avoid being sedentary.
- Include muscle strengthening and flexibility training in the activity regimen.
How Much Physical Activity Do Older Adults Require?
Current recommendations are that adults age 65 years or older who are generally fit and have no limiting health conditions should do a least 150 minutes of moderate-intensity activity throughout the week, or an equivalent combination of moderate- and vigorous-intensity activity. It is thought that aerobic activity can be broken up into smaller chunks of time during the day, as long as they are at least 10 minutes each. If chronic conditions preclude activity at the recommended minimum amount, older adults should perform physical activities as tolerated to avoid being sedentary. In addition to aerobic activities, exercise prescriptions for older adults should also include muscle strengthening and flexibility exercises performed at least twice weekly.

How Does it Work?
While observational studies have demonstrated an association between exercise and preserved cognition in older adults, causation has not been unequivocally demonstrated. If there is a causal mechanism, any of several mechanisms could be involved.

For example, a number of studies have been conducted to examine the effect of exercise on human brain structure and function. Research using fMRI have demonstrated that increased cerebral blood volume in the dentate gyrus of the hippocampus, a center involved in memory, occurs in association with improvements in cardiorespiratory fitness and performance in verbal learning and memory. Other mechanisms might include stimulation of neuroplasticity, improving neuronal function, up-regulating growth factors, increasing neuroendocrine response to stress, decreasing neuro-inflammation, and/or reducing neuro-pathologic load. Improvements related to dual-task performance might be due to a better coordination of cognitive resources and improved attention-control strategies. Non-human animal research has had similar findings and has contributed to our understanding neurocognitive plasticity in humans.

However, many unanswered questions remain in the field of exercise neuroscience. Nonetheless, there is accumulating evidence that physical exercise has benefit. It should be encouraged in all older adults, including those with mild cognitive impairment and dementia.

In summary, older adults gain substantial health benefits from regular physical activity, including potential positive effects on cognitive performance.