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**Abstract:**

As the population ages, risks for cognitive decline threaten independence and quality of life for older adults and present challenges to the health care system. Nurses are in a unique position to advise clients about cognitive health promotion and to develop interventions that optimize cognition in the growing aging population. A literature review was completed to provide nurses working in mental health and geriatric care with an overview of research related to the promotion of successful cognitive aging for older adults. Research evaluating cognitively stimulating lifestyles and the effects on cognitive function of older adults of interventions targeting cognitive training, physical activity, social engagement, and nutrition were reviewed. Overall research findings support positive effects of cognitive and physical activity, social engagement, and therapeutic nutrition in optimizing cognitive aging. However, the strength of the research evidence is limited by research designs. Conclusions include recommended applications for health promotion to optimize cognitive aging and future direction for research.

**Text of paper:**

Exploring Interventions to Reduce Cognitive Decline in Aging

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As the population ages, risks for cognitive decline threaten independence and quality of life for older adults and present challenges to the health care system. “Brain health” programs developed by aging interest groups such as the American Association of Retired Persons (AARP & Initiatives, 2004) and the Alzheimer’s Association (Alzheimer's, 2006) provide directives for nutrition, physical and cognitive activities, and other lifestyle modifications to enhance older adults’ cognition and memory. Computer training, memory tapes, and Nintendo games are also marketed to the lay public with claims of enhancing cognition, assuming that “use it or lose it” applies to cognition as well as physical health (Casel, 2002). As health care experts, nurses may be asked to advise older adults about ways to optimize cognitive abilities in aging.

Geriatric and mental health nurses are in a unique position to identify changes in elder clients’ cognition, distinguishing between normal and pathological processes but also providing guidance in cognitive health promotion. Thus, nurse clinicians need to become knowledgeable about cognitive aging as a basis for educating clients and for developing and testing interventions to promote cognitive wellbeing. This paper provides an overview of the current state of the science in cognitive aging and a review of recent research with implications for practice and future research.

The review was conducted by identifying research reports completed since 2000 by searching the terms “cognition” and “aging” in Medline, CINAHL, and Psych Info data bases. More specific search terms including “lifestyle factors,” “cognitive and exercise interventions,” and “social engagement” were included to narrow topics and to organize the review.

### Cognitive Changes of Aging

Knowledge of the normal and pathological changes in cognition that occur in aging is essential background to understanding interventions to optimize cognition in older adults.

“Normal” cognitive aging includes established declines in a number of cognitive processes that affect every day functional abilities for older adults such as driving, banking, and medication administration (Fillit et al., 2002). Cognitive functioning or intelligence includes a wide array of abilities such as use of symbols and abstractions, acquiring new information, and adapting to changing situations. The standard intelligence quotient was developed to provide an index of intelligence, including assessment of mathematical reasoning, word fluency, vocabulary, inductive reasoning, and spatial orientation. Intelligence, learning, and memory are three key cognitive domains that normally change during aging and have implications for maintaining independence and quality of life (Hooyman & Kiyak, 2007).

The Seattle Longitudinal study was a large longitudinal randomized controlled clinical trial that established changes in cognitive abilities with aging. This study included repeated cognitive assessments of the membership population of a Health Maintenance Organization. Baseline measures were collected in 1956 and continued over seven intervals. Contextual, health, and personality variables were factored into the analyses of relationships of specific cognitive abilities to real life tasks (Schaie, Willis, & Caskie, 2004).

The Seattle Longitudinal study established that patterns of age-related decline in specific intellectual abilities vary among aging individuals, but fluid (or process based) intelligence declines earlier than crystallized abilities (based on the accumulation of knowledge). Fluid processing declines occur at younger ages in women, potentially exacerbating the increased prevalence and progression of cognitive disability for this population. Even crystallized (content based) abilities decline dramatically for older adults by the late 70s, and reductions in perceptual speed start in young adulthood. Generally, some cognitive functional loss is measurable by age 60, with more widespread declines by age 75 for most but not all individuals (Schaie, Willis, &

Caskie, 2004). Over the past decade, research has focused on determining why some elders have preserved cognitive function in aging as a basis to develop and test interventions to maintain cognitive abilities of older adults.

### *Theories of Cognitive Aging*

Understanding the mechanisms of cognitive processes and changes that occur with advancing age is helpful to appreciate this field of research. Theoretically, age-related cognitive changes normally occur as outcomes of distal or proximal life events. Distal events are early life experiences such as physical, cultural, and social conditions that influence cognitive development and functioning over time. For example, vocabulary becomes increasingly diverse with age. In contrast, current cohorts of elders were not exposed to computers as children and young adults, thus computer technologies pose challenges to them. Failure to continue to use established cognitive abilities can also lead to declines in cognitive performance (Fillit et al., 2002).

Additional proximal (recent) factors are also responsible for reduced cognitive performance in old age. A number of cognitive abilities including processing speed, size of working memory, inhibition of extraneous environmental stimuli, and sensory losses affect multiple serial cognitive processes contributing to cognitive decline. True cognitive capacity remains intact with aging, but encoding, storage, and retrieval components of processing become less efficient or are interrupted by reduced attention and working memory capacity (Fillit, et al., 2002). Slowed processing speed can interfere with problem solving by extending the time required for an older adult to perceive, interpret, select, and execute responses.

Reduced working memory has been attributed to slowed processing involving the sequence of recall (Kramer, Bherer, Colcombe, Dong, & Greenough, 2004). Limited amounts of

information are held in working (short-term) memory for immediate recall or are encoded and stored in secondary (long-term) memory. In aging, actual memories are preserved. However, short term memory (the amount of information held in immediate consciousness) is reduced, and retrieval of information from long-term memory stores is slowed. Reductions in the efficiency of encoding and recall, in attention, and in brain plasticity (the ability to adapt to novel information) are also implicated as normal changes in cognitive aging (Hooyman & Kayak, 2007).

Recognizing the significance of cognitive health for the growing population of older adults, three Institutes (Aging, Mental Health, and Neurological Diseases and Stroke) in the National Institutes of Health (NIH) recently united to identify demographic, social, and biological determinants of cognitive and emotional health in older adults (Hendrie et al., 2006). A committee of experts performed a critical analysis of large longitudinal and cross sectional cognitive aging research studies as a basis for directing future research. Key recommendations included acknowledging the link between emotional and cognitive health and the need for researchers to use broad and consistent outcome measures. Four factors were identified as influencing cognitive performance in older adults that should be included in ongoing research: socioeconomic status, education, psychosocial factors (emotional support, social networks, stress management), and physical activity. The panel advised that research on healthy brain aging should be a priority for the nation.

The four factors identified as a focus for future research will provide the framework for this review to examine the effects of cognitive and physical activity, social engagement, and nutrition on cognition in aging. The review will first present research assessing associations with established lifestyle practices that provide evidence to support the development and testing of

cognitive interventions within the four focus areas. Secondly, studies testing cognitive interventions targeting the four focus areas in more rigorous research designs will be reviewed.

### Lifestyle Factors Associated with Maintained Cognition

Researchers have examined lifestyle practices of older adults who have successfully maintained their cognitive abilities into advanced ages. These studies evaluate how education, leisure pursuits, intellectual engagement, and expertise in specific cognitive domains influence cognitive aging. Associations among physical activity, diet, and social activity factors have also been explored as a first step to direct development and testing of interventions to prevent cognitive decline in aging.

#### *Cognitive Activity Factors*

A number of studies have compared naturally occurring differences in cognitive functioning for persons who engage in cognitively demanding versus less demanding activities. It has been established that education exerts protective effects on memory and crystallized intelligence (accumulated knowledge), with minor effects on fluid cognition (processing speed and abilities). The MacArthur Studies of Successful Aging established that increased education has both psychological and physiological benefits in aging individuals (Kubzansky et al., 1998). In a community dwelling sample, cognitive inactivity was associated with reduced performance on fluid intelligence measures, while use of cognitive abilities overcame some effects of low educational level (Christensen et al., 1996). Other research suggests that socioeconomic status and prior life experiences have significant effects on cognitive performance in older adults (Kramer et al., 2004).

Persons with cognitively stimulating occupations have been found to maintain higher cognitive functioning with aging. Professionals, including college professors, pilots, physicians,

musicians, and architects have been studied as high cognitive activity groups. Occupational complexity, defined as mental activities demanding thought processing and independent judgment, has been positively correlated with intellectual flexibility, memory, verbal abilities, fluency, and visual spatial measures in aging (Schooler, Mulatu, & Oates, 1999). Despite the fact that older adults in cognitively demanding occupations function higher than age mates, their performances on cognitive measures in their area of expertise eventually show declines with advancing age (Salthouse, 2006).

Chess and bridge are popular leisure activities that demand working memory and reasoning skills. Older adults who were bridge players demonstrated higher scores on two working memory and two reasoning measures compared to nonplayers (Clarkson-Smith & Hartley, 1990a). Crossword puzzles also enhance cognitive functions in older adults (Mireles & Charness, 2002). However, other research on self-selected leisure activities failed to support these findings. Subject reports of frequency of participation on an activities checklist (rated for degree of cognitive demand) were not associated with higher cognitive performance in a subsequent study (Salthouse et al., 2002). Although the majority of correlational studies suggest that cognitive activities benefit cognition in aging, more rigorous research designs will be needed to establish causal relationships.

### *Physical Activity Factors*

A growing number of research studies investigate the potential physiological benefits of physical exercise in aging; however few studies examine potential cognitive benefits.

Theoretically, physical activity should enhance cognitive aging as cardiovascular fitness increases cerebral blood flow and oxygen delivery to the brain, increasing neuron formation and maintaining brain volume (Etnier, Nowell, Landers, & Sibley, 2006). A few studies have

examined associations between established physical activity levels and cognitive function.

Cognitive function was assessed over time in relation to reported physical activity.

Yaffe and colleagues (Yaffe, Barnes, Nevitt, Lui, & Covinsky, 2001) investigated women over 65 who were physically and cognitively healthy at baseline. Participants reported the number of blocks they walked at baseline (also used to estimate caloric expenditure). Those who reported higher baseline walking (adjusted for health, medication, and lifestyle factors) were significantly less likely to demonstrate cognitive declines in the follow-up Mini Mental Status Examination (MMSE) 6 years later.

Data from the Nurse's Health Study (N=1800) also provides evidence that physical activity reduces risks of cognitive decline and dementia in aging. Baseline reports of activity and corresponding energy expenditures for 70 to 81-year-old participants were regressed on longitudinal cognitive measures. A 20% risk reduction for cognitive decline was reported for the group reporting the highest levels of physical activity (Weuve et al., 2004).

A European study evaluated the reported early life and subsequent physical activity in relation to later life changes in cognitive function. Participants who maintained or increased their physical activity were 3.6 times less likely to exhibit cognitive decline (measured by MMSE scores). Men in the lowest activity quartile at baseline had significantly elevated risks for cognitive decline as they aged (van Gelder et al., 2004).

Another study of over 1,000 older adult residents of rural communities evaluated the relationship between self-reported exercise habits and MMSE scores over a 2-year interval. Multiple regression analyses determined that the highest exercise group had an odds ratio of 0.39 (95% CI 0.19, 0.78) for either a three-point decline in MMSE or inclusion in the highest quartile of cognitive decline. Even the least frequent and strenuous level of exercise exhibited some

protective effects for cognition in this study (Lytle, Vander Bilt, Pandav, Dodge, & Ganguli, 2004).

Structural equation modeling was used in another study of 300 persons over age 55 that examined relationships between exercise and cognitive abilities in which health, education, subjective well being, and aging were considered (Clarkson-Smith & Hartley, 1990b). Exercise mediated cognitive functioning and each of the other variables. The model that best explained cognitive performance included age, health, education, morale, and exercise, reaction time, working memory, and reasoning, suggesting a positive relationship between exercise and cognitive aging.

### *Social Engagement Factors*

Other researchers have examined the effects of social support and engagement in social activities on cognition in aging. Social and productive activities can lower mortality outcomes similar to those of physical exercise programs (Glass et al., 1999). As part of the Epidemiological Study of the Elderly (EPESE), over 2000 randomly selected community-dwelling older adults reported their social engagement within the domains of social, fitness, and productive activities. Elders with higher levels of social activity had lower mortality rates after 13 years, controlling for age, sex, race/ethnicity, marital status, income, body mass index, smoking, functional disability, and history of cancer, diabetes, stroke, and myocardial infarction.

A longitudinal cohort analysis of EPESE data measured social engagement, defined as having a spouse, frequency of visual and other contacts with friends and family, church attendance, group membership, and regularly scheduled social activities. Older adults with fewer social ties were at increased risk for cognitive decline, measured with the Short Portable Mental Status Questionnaire, after controlling for age, initial cognitive level, sex, ethnicity, education,

income, housing type, physical disability, cardiovascular disease, sensory deficits, depression, smoking, alcohol use, and physical activity. The 12 year odds ratio for avoiding cognitive decline was 2.37 (CI = 1.07 – 4.88) for socially involved elders (Bassuk et al., 1999).

Another EPESE study included nine annual interviews with elders to measure social engagement as well as Activities of Daily Living abilities and disabilities. Available social contacts, not actual support received, were associated with a significantly reduced risk of developing ADL disability (Mendes de Leon et al., 1999). Still another analysis of this data set suggested that actual involvement with one's social network, not just an available network, was protective against cognitive decline (Seeman, Lusignolo, Albert, & Berkman, 2001).

Productivity, defined as participation in 18 activities within five domains (housework, yard work, childcare, paid work, and volunteer work) was also examined in relation to cognition (Glass et al., 1995). Elders with the highest levels of cognitive functioning were also the most productive, or active.

A study of 350 older adults used multivariate analysis to examine relationships between social network characteristics (network size, contact frequency, and emotional support received) in relation to changes in global cognition (MMSE) over 12 years. Actual engagement and receipt of emotional support, not just the availability of a social network, provided protective effects on cognition (Holtzman et al., 2004).

Trajectories of cognition and social relations were examined over a 7-year period in a study that determined that social integration, family ties, and engagement with family were all associated with maintained cognitive function in older adults. Specifically, social integration, reflected by participation in community activities, was protective of cognitive abilities in the most advanced age cohorts (Beland, Zunzunegui, Alvarado, Otero, & del Ser, 2006).

### *Nutritional Factors*

Nutrition has been identified as one of many factors implicated in successful cognitive aging as well as in abnormal cognitive decline including dementia. The limited research in this area uses cohort studies to identify nutritional intake and related metabolic indicators correlated with cognitive status in aging populations (Gonzalez-Gross, Marcos, & Pietrzik, 2001; Morris, 2006). Research suggests that diet and supplements such as antioxidants, vitamins, fats, and minerals, suggested for common chronic diseases such as hypertension, hyperlipidemia, and diabetes, also may have beneficial effects on cognitive aging. Increased vascular disease factors and inflammation markers, such as homocysteine, are implicated in abnormal cognitive declines and dementia. Vitamins B<sup>6</sup>, B<sup>12</sup>, and folate may be of benefit by metabolizing homocysteine to reduce blood levels. Diets featuring polyunsaturated fats and omega 3 fatty acids are also associated with maintained cognition in older adults, while transfats and saturated fats related to increased cognitive decline. Trace minerals such as copper, zinc, and iron are believed to interact with dietary fats to increase risks for cognitive decline. Antioxidants, such as Vitamins C and E, that show promise in limiting vascular inflammation processes are also being evaluated as supplements to reduce cognitive declines for aging adults (Gonzalez-Gross et al., 2001; Morris, 2006).

Community-dwelling African elders who were malnourished were included in a study examining their reported dietary intake and MMSE scores. Participants taking supplemental vitamins had significantly higher cognitive scores, suggesting a protective cognitive effect of vitamins in malnourished older adults (Ojofeitimi et al., 2002). Nutrient analyses were correlated with cognitive scores of rural-dwelling Italian elders, controlling for age, gender, education, total energy intake, cigarette smoking, alcohol consumption, and physical activity (Correa Leite,

Nicolosi, Cristina, Hauser, & Nappi, 2001). A healthy diet was protective against cognitive decline (cumulative odds ratio was 0.85, 95% CI 0.77-0.93). A third study examined 463 70 year-old Middle Eastern elders, and found a significant interactive effect of good nutrition on ADLs and cognition (Maaravi, Berry, Ginsberg, Cohen, & Stessman, 2000).

More recently, studies have been initiated to further explore specific nutritional factors in relation to cognitive aging that may lead to nutritional standards for older adults. The Third National Health and Nutrition Examination Survey (NHANES III) has added a nutritional survey to other lifestyle and health factors that are examined as predictors of chronic conditions in the United States (Burt & Harris, 1994). The Nutrition, Aging, and Memory in Elders (NAME) study is also in progress and will evaluate potential relationships between multiple cognitive measures and blood levels of hematological factors, electrolytes, micronutrients, macronutrients, minerals, proteins, amino acids, lipids, and genetic markers in homebound elders who are at risk for cognitive declines (Scott et al., 2006). These efforts will add to knowledge of how nutrition can improve cognitive performance in older adults.

### *Summary of Correlational Research*

Overall, correlational research supports the association of cognitive and physical activity, social engagement, and balanced nutrition with maintained cognitive performance in aging, although some studies report conflicting findings. Suggested protective effects must be interpreted cautiously because correlational research designs fail to establish cause and effect relationships. Correlational studies also favor self-selecting samples of “successfully aging” elders who are not representative of the population at large. Although convenient, cross-sectional designs may also be affected by cohort effects (ways that one generation varies from another), preventing the isolation of true age-related cognitive trends. For example, reduced mathematical

abilities of elders may be a product of limited secondary education in mathematics when they attended school, not a result of aging.

Although longitudinal studies examining associations between established lifestyle factors and cognition can overcome cohort differences to identify true cognitive changes, subject attrition frequently results in increasingly biased samples of successfully aging individuals. Variation in performance in different cognitive domains and within cohorts also confounds the identification of age-related changes. Complex research designs with large sample sizes are needed to control for multiple additional factors such as personality, education, occupation, and sensory and physical health to provide valid results. Failure to identify and control for these additional factors that impact cognitive aging limits conclusions drawn from correlational research designs. For example, persons of higher socioeconomic status can afford higher education that is more cognitively stimulating and logically leads to cognitively challenging professional careers. Professional careers, in turn, support privileged lifestyles that engender well-being. Intensity of cognitive stimulation is difficult to quantify and may vary between individuals and among individuals across activities. Reliance on participant-reported outcome measures may result in inaccuracies and bias.

The research on nutritional intake illustrates typical correlational design challenges. Control of older adults' past dietary practices is impossible, and inaccuracies in reports of current dietary intake complicate research in humans. Thus nutritional research is frequently conducted on animals, where cumulative nutritional practices and other confounding lifestyle factors can be controlled. Human studies have primarily examined cohort effects in international older adult populations with identified nutritional deficiencies or in cross-sectional cohort studies.

The Nun Study (Snowdon et al., 1996) is an example of research that successfully controlled for the many additional factors that potentially influence cognitive aging. This study determined that cognitively stimulating activities protect against cognitive decline, controlling for lifestyle factors. Diaries of novice nuns entering the convent in adolescence and their periodic entries across their lifespans were analyzed, comparing linguistic complexity, which is an indirect measure of cognition. Nuns entering the convent with lower linguistic complexity typically engaged in less cognitively stimulating roles in the convent and had higher rates of dementia in later years as confirmed on autopsy. Nuns whose initial narratives were more complex were less likely to exhibit dementia, even though plaques and tangles may have been present on autopsy. This study controlled many lifestyle factors such as diet and environment but not the earliest life experiences. The availability of samples that permit this level of control is limited, and future research designs using advanced statistical techniques will be needed to adequately address and control the complex of factors that affect cognitive aging.

Correlational research provides evidence of how lifestyle factors effect cognitive performance in aging. However, these effects may only partially determine cognitive performance for older adults. One study examined paired association recall for adults 60 to 70 years old and determined that only 25% of performance differences could be attributed to age (Salthouse, 2006). To clearly establish an effect of cognitive activity on altering age-related cognitive declines, research must demonstrate differences in cognitive functioning between high- and low-stimulation groups that increase with age (Salthouse et al., 2002). Despite multiple limitations, research examining associations between naturally occurring or self-selected activities provides a basis for identifying interventions to improve cognitive aging.

## Testing Interventions to Optimize Cognitive Aging

Based on correlational research, interventions have been developed that target cognitive and physical activity, social engagement, and diet. These interventions must be tested in research using varied designs to provide causal evidence of the effects of cognitive, physical, social, and nutritional interventions designed to preserve cognition in older adults.

### *Cognitive Interventions*

Targeted cognitive interventions or training are becoming popular, especially interventions focused on memory. Memory training classes have demonstrated that elders, like young adults, can improve their performance on cognitive tasks including perceptual discrimination, visual search, recognition, recall, and spatial perception (Kramer et al., 2004). Memory training for healthy older adults typically teaches mnemonic strategies, concentration and attention, relaxation, personal insight, self-monitoring, motivation, feedback, and problem solving that have succeeded in improving memory performance (Verhaeghen, Marcoen, & Gossens, 1992).

One study compared the effectiveness of three different memory training formats: group-based training, self-directed memory-tape training, or computer-based training. All the interventions involved 90-minute sessions delivered over 9 weeks. The training featured mnemonic and external strategies such as list making. Improved memory performance and decreased depression were noted across all groups, although none of the groups reported increased memory confidence (Rasmusson, Rebok, Bylsma, & Brandt, 1999). The most improvement occurred in the healthiest participants. Based on these findings, additional research in populations with declining health is warranted.

Memory training that incorporated stress inoculation, health promotion, and memory self-efficacy support has also been tested in older adults in a retirement village and assisted living residences (McDougall, 1999; 2000). Improved memory performance and efficacy beliefs were reported post-intervention in this population of frail elders. However, improved memory performance did not translate into improved performance in activities of daily living (ADLs). This study identified that depression was negatively correlated with memory performance and suggested that memory interventions may impact other outcomes that improve quality of life.

The effects of individual versus group memory-training classes for community dwelling older adults have also been studied. Although no statistical difference in effectiveness between formats occurred, effect sizes for memory training (.73-.86) exceeded effect sizes for the control group (a .38 increase most likely due to practice effects) (Scogin, Prohaska, & Weeks, 1998). This study tested a wide battery of outcomes including immediate and delayed recall, subject-reported memory failures, self-efficacy, use of memory strategies, and psychiatric symptoms, as well as reports of subjects' significant others. Both training formats improved memory, increased use of memory strategies, and reduced memory failures. Effects were maintained at the 6 month follow-up reassessment without intervention boosters.

The Seattle Longitudinal Study (Schaie et al., 2004) identified older adults with existing declines in either inductive reasoning or spatial orientation performance and provided a brief (5 hour) training program designed to improve these skills. Two-thirds of participants demonstrated improvement with 40% returning to a baseline level obtained 14 years earlier. Ongoing effects continued up to 7 years after training. This study supports the value of cognitive training for these specific cognitive abilities that normally decline in aging.

The Advanced Cognitive Training for Independent and Vital Elderly (ACTIVE) clinical trial provided strong evidence of cognitive training effectiveness. Two thousand healthy, community-dwelling older adults were randomly assigned to one of three training groups or to a no-contact control group (Ball et al., 2002). Ten training sessions were provided for (1) verbal episodic memory, (2) inductive reasoning, or (3) processing speed. Immediate post-training improvements occurred in specific targeted skills that continued for 2 years.

The 5-year follow-up for the ACTIVE study reported that the 10-session cognitive training followed by four booster treatments resulted in both better performance on training specific domains (memory, reasoning, or processing speed) and in less functional decline in instrumental activities of daily living (IADLs) for the inductive reasoning group (Willis et al., 2006). Experimental (versus control) group participants were less likely to suffer significant declines in health related quality of life (Wolinsky et al., 2006). These findings provide direction for ongoing research to test interventions that are meaningful for daily function valued by older adults.

### *Physical Activity Interventions*

A meta-analysis of 18 clinical trials examining the impact of fitness interventions on cognitive processes of older adults reports definite benefits for executive functions, higher level functions including planning, abstraction and selection of relevant sensory information (Colcombe & Kramer, 2003). The analysis examined the type of exercise intervention as well as the duration of training sessions and the length of involvement. Cardiopulmonary improvement ( $VO_2$  max.) was also analyzed. Global cognitive improvements were noted in both the experimental and control groups. The strongest effects on executive function were noted for combined aerobic exercise and strength training interventions and for more intensive exercise.

Women demonstrated greater gains, possibly due to lower baseline exercise levels (Kramer, Colcombe, McAuley, Scalf, & Erickson, 2005).

A meta-regression analysis of cross-sectional and pre- and post-test exercise intervention research found no differences in cognitive performance for physically fit versus sedentary groups. Relatively small effect sizes of 0.25 were noted for post-intervention changes in the pre- and post-test design studies, although post-intervention cognitive functions declined contrary to the hypothesis (Etnier et al., 2006). The analysis indicates that on average fitness explained only a limited (8%) amount of the variation in cognition.

Research testing the effects of physical exercise on cognitive aging supports benefits of physical activity on preserving cognitive function in aging. However, evidence is limited by selection bias and primary reliance on MMSE scores that may not be sensitive to subtle cognitive changes to measure cognition.

### *Social Interventions*

Based on evidence of the protective effects of social involvement and productive activities on cognition in aging, a model program (Experience Corps) was implemented and tested as a cognitive protective intervention in a randomized clinical trial (Fried et al., 2004). Older adults worked with elementary school students in supportive interactive roles for 15 hours weekly over the school year. Physical activity, strength, reported social support networks, and cognitive activity significantly increased for these elders. This program is a novel start in targeting social engagement interventions to enhance cognitive aging for older adults. These studies support the theory that active involvement with society and engagement in meaningful activity are critical to “successful aging” (Rowe & Kahn, 1997).

### *Nutritional Interventions*

Clinical trials focusing specifically on nutrition and cognitive aging are needed to further explore nutrition as a potential intervention to improve cognitive function for older adults. In a 2005 study, a small (N=67) group of frail older adults with limited or no measurable cognitive declines was included in a 6-month trial testing a daily enriched drink on cognitive measures (Wouter-Wesseling et al., 2005). Short and intermediate memory improved, and plasma B<sup>12</sup> increased in the experimental group while homocysteine levels declined.

### *Evaluation of Intervention Research*

Studies that evaluate the outcomes of cognitive interventions have recently been initiated and provide introductory evidence of effectiveness. However, many of these studies fail to isolate specific cognitive domains, and inconsistency in use of outcome measures makes interpreting results across studies challenging. In addition, other limitations complicate studies testing cognitive interventions. Most research reports benefits from physical activity on preserving cognitive performance in aging. However, evidence is limited by sample selection bias and primary reliance on outcome measures such as MMSE scores, which may not be sensitive to subtle cognitive changes to measure cognition.

Thus research using rigorous designs with common outcome measures is needed to allow comparison across multiple studies. Increasingly sophisticated research designs using *significant* sample sizes are needed to meet criteria for representative populations as well as to control the multiple factors that may affect cognition in aging.

### **Implications for Ongoing Research**

Research has begun to examine how lifestyle factors, physical and mental activity, social

engagement, and nutrition affect changes in cognitive functions with advancing age. Overall, these studies provide initial support for the premise that physical and mental activity, social support, and balanced nutrition provide protective effects on cognition in aging. Ongoing research is needed to verify these findings and to identify and isolate specific factors that positively influence cognitive changes that occur with aging. In addition, potential synergistic effects of interventions combining cognitive and physical exercise, social engagement, and nutrition should be explored.

Research designs must move beyond convenient cross-sectional studies to longitudinal trials that can establish causal relationships and control for the numerous confounding factors such as lifestyle variables that may impact cognition. Sensitive outcome measures must be identified and used consistently among investigators to enable synthesis of findings from multiple studies. Research must assess whether cognitive gains improve everyday competence and functioning critical goals to the well-being of older adults, must be assessed. Associated effects of cognitive interventions on improving mood and reducing depression should continue to be explored as secondary outcomes. Clinical trial testing of interventions will be critical to advance this area of health promotion for an aging population.

To overcome sampling that favors inclusion of the healthiest elders and fails to reflect a representative population of older adults, additional research is needed to evaluate potential restorative and preventive cognitive interventions for older adults with different cognitive and physical conditions. Testing of interventions must also compare age ranges of older adults to determine optimal timing or critical periods for intervention effectiveness. Future research must more consistently evaluate the impact of cognitive training on ADLs and IADLs to identify interventions that promote maintenance of everyday competence and independence that will

make meaningful contributions to the quality of life of aging adults. Analyses comparing the benefits and effectiveness of different cognitive interventions will establish best practices for cognitive health promotion.

Additional research must establish (1) optimal formats, lengths, and durations of interventions; (2) whether boosters are necessary to maintain effects; and (3) how to target interventions to individual cognitive levels. Clinical trials will be essential to provide firm causal evidence of cognitive training effectiveness. Research must be designed to demonstrate that interventions result in differential rates of decline in cognitive function within specific age groups.

#### Implications for Practice

Clinicians working with older adults in a variety of settings can incorporate knowledge of the beneficial effects of cognitive activity, physical exercise, social involvement, and nutrition into health promotion for older adults. Older adults reporting cognitive declines (such as memory loss) should undergo cognitive testing. Testing that distinguishes normal versus pathological changes will enable clinicians to provide reassurance to most older adults that they are experiencing changes as a normal part of the aging process. Reassurance may alleviate undue anxiety, depression, and social isolation due to fear others will notice cognitive decline.

Anticipatory guidance for older adults should be expanded to focus on cognitive as well as physical health. Within a holistic framework, nurses should routinely counsel patients on cognitive benefits of social engagement, balanced nutrition, and physical activity as well as participation in cognitively demanding activities. Families and significant others should be made aware of the cognitive benefits associated with maintaining social connections and activities with elder family members. Counseling should go beyond emphasizing the physical benefits of a

balanced, therapeutic diet to explain the added cognitive benefits that may be realized.

Knowledge that therapeutic diets prescribed for common chronic conditions such as cardiovascular disease and diabetes may have protective cognitive effects may increase diet adherence in older adults. Older adults may also be advised to add new cognitive, physical, and social activities, and improved nutrition to support successful cognitive aging, although additional research clearly documenting the cognitive benefits of initiating these activities in older adults is needed to clearly establish benefits.

Findings of current research suggest that supportive care for older adults must incorporate activities that prevent or limit cognitive disabilities in older adults. Cognitive and physical activities, social engagement, and nutrition to support successful cognitive aging must become integral to elder care. Cognitive interventions may support older adults in maintaining self-care as well as cognitive performance into advanced ages. For example, community dwelling older adults who comprehend and follow prescribed medication regimes may be able to extend aging in place at home compared to those with more substantial cognitive decline.

Potential benefits of cognitively supportive long-term care environments may overcome the negative stigma of moving to assisted living or nursing home settings. Health care workers in institutions caring for older adults must be cognizant of how important physical, cognitive, and social activities and adequate nutrition may be to maintain cognitive abilities for older adults. Programs tailoring activities to the appropriate cognitive levels of the diverse older adults living together in these settings also need to be explored. Ongoing awareness of future research will be important for promoting successful cognitive aging for the growing population of older adults.

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