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DEMENTIA RISK  
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## **EDUCATION AND COGNITIVE ENGAGEMENT: CHALLENGE YOUR MIND**

The Public Health Center of Excellence on Dementia Risk Reduction coordinates risk reduction efforts and helps public health agencies share best practices. The Center translates the latest science on dementia risk reduction into actionable tools, materials and messaging that public health agencies can use to reduce dementia risk for all people — including those in diverse, underserved and higher-risk communities.

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# EDUCATION AND COGNITIVE ENGAGEMENT

## WHAT IS ALREADY KNOWN

Enriched educational and cognitive experiences are linked to lower dementia risk. Research is exploring key mechanisms, such as the stronger impact of education quality and literacy compared with the number of years of schooling. Early education shapes cognitive ability, while lifelong enrichment through work and leisure more strongly affects cognitive decline. Animal studies show that cognitive enrichment fosters neural growth, even in old age. Brain plasticity persists lifelong and is influenced by behavior and lifestyle. These findings suggest cognitive enrichment both in early critical windows of life and throughout the lifespan impart unique opportunities to support brain health.

## BACKGROUND AND EVIDENCE BASE

### *Evidence from preclinical studies*

Animal studies show that brain structure and function remain responsive to external experiences throughout life. In adults, up to 10% of synapses can turn over within a single week. Aged animals in cognitively enriched environments develop more complex neural connections, larger cell bodies, and increased neuron counts. Novelty appears to be a key factor: repeated exposure to the same tasks yields limited benefits, while new stimuli and challenges promote the formation of new brain cells and connections. Most human studies on cognitive enrichment are observational, limiting causal conclusions. However, preclinical findings support a causal role for sustained, novel mental stimulation in promoting brain health and inform our understanding of cognitive enrichment in humans.

### *Evidence from clinical studies*

In human studies, cognitive enrichment is often divided in three domains of life: 1) educational quality and attainment, 2) occupational demands, and 3) leisure activities.

**Educational quality and attainment:** Educational attainment continues to increase globally, a trend that has been directly linked to decreased rates of incidence of dementia including in the United States. Inclusivity in educational opportunities continues to be a challenge, although the gender gap, which may have historically contributed to higher dementia risk in women, is closing. Years of educational attainment are robustly associated with level of cognitive ability and lower odds of dementia across multiple studies. However, whether education

relates to the rate of cognitive decline with age is debated. Several meta-analyses and large-scale epidemiologic studies suggest that education may instead promote a higher cognitive starting point and greater capacity to maintain cognitive function in the face of neuropathologic changes (e.g., Alzheimer's plaques and tangles) versus slowing overall rate of cognitive aging. These patterns suggest that education may promote one's "cognitive reserve".

Additionally, the mechanisms of education on dementia are likely multifaceted. Several studies suggest that educational quality (as measured via literacy and reading levels) but not quantity may be a key ingredient. Among adults with similarly low education in the United States (<5 years), those who were not literate demonstrated a three-fold increased risk of having dementia at baseline and a two-fold risk of developing dementia over the study period. Quality of education is a critical consideration when examining systematic disparities in educational opportunities across historically underserved populations in the United States, such as racial and ethnic minorities and women. Other key mediators of education include intelligence, occupational attainment, and health literacy. One recent study using genetic predictive models showed that intelligence and education were bidirectionally related to one another and to dementia risk, but that the effects of education on dementia risk were explained via intelligence. Further, combined analyses examining seven population-based studies showed that education and occupational complexity independently contribute to dementia risk; however, there was a stepwise pattern such that the greatest protection was conferred in adults with both higher education and occupational complexity. Notably, over a quarter of the effect of education on dementia risk was explained through occupational attainment, highlighting the important overlap among these interrelated factors (education, intelligence, and occupational attainment).

**Occupational demands:** Occupational activities are another central source of sustained cognitive stimulation that appear to offer protection against future dementia risk. High stimulation occupations are conceptualized as positions that have demanding tasks and high job decision latitude (e.g., "job control"). In a seminal study showcasing how occupation may shape the brain, taxi drivers in London, a city known for its complex street system, had significantly larger volumes in the areas of the brain responsible for spatial navigation and memory (posterior hippocampus) compared with non-drivers or even

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compared with bus drivers who navigate a prescriptive route each day. Ongoing cohort and epidemiologic studies continue to replicate these effects. A recent population-based study estimated that adults engaged in occupations with higher cognitive stimulation demonstrate 21% decreased risk of dementia 10 years later. Beyond cognitive stimulation, there are likely multiple neuroprotective factors that contribute to occupation-related brain health, including access to health care, financial resources, social connection, and sense of purpose, all of which have been previously linked to dementia risk and continue to be an area of study.

**Leisure activities and cognitive training:** Cognitively stimulating leisure activities are defined as unstructured, enjoyable activities that engage and challenge the mind, often involving learning, novelty, or problem-solving, and are independent of work or routine daily tasks. The activities should be something that is challenging or involves learning something new. A systematic review of five meta-analytic studies showed that greater engagement in mentally stimulating activities was associated with a 31% reduced risk of cognitive impairment and a 42% reduced risk of dementia, as well as better overall cognitive performances and slower cognitive decline. A study of monozygotic twins who share the same genetic make-up demonstrated a 26% reduced risk of dementia in the twin who engaged in greater cognitive and social activities during midlife — an effect that was particularly prominent in twin dyads who had high genetic risk for Alzheimer’s disease (APOEε4 carriers). These findings highlight the importance of novelty and mental challenge in maintaining cognitive benefits. Activities that once stimulated the brain may lose their effect if they become habitual or passive, highlighting the need for ongoing learning and adaptation.

Other opportunities to directly engage in cognitive stimulation are through increasingly available cognitive training platforms. A recent Cochrane review evaluating the evidence on randomized controlled trials (RCTs) that tested computerized cognitive training paradigms in normal older adults suggested there may be small benefits in global cognitive skills following brief (12–26 week) training programs. However, there was notable heterogeneity in the dose, duration, intensity, and methodological approaches (e.g., lack of blinding, small samples) of studies that contributed to overall low quality of evidence and unclear persistence or domain specificity (e.g., memory vs. processing speed) of these benefits. Ultimately, computerized training platforms may be

beneficial but are a financial and time investment, given the evidence supporting beneficial effects of many other types of (often free) leisure cognitive activities.

## IMPLICATIONS FOR PUBLIC HEALTH

Educational quality, lifelong learning opportunities, and health literacy represent key public health opportunities for reducing dementia risk. In fact, trends showing generational increases in educational access and quality track with decreased dementia incidence rates in the United States. Education promotes cognitive ability level (“cognitive reserve”), which enhances the brain’s ability to cope with age-related changes and neurodegenerative diseases. In addition to formal education, engaging in cognitively stimulating occupational and leisure activities — such as reading and learning new skills — can further support cognitive health into the oldest ages. Promoting equitable access to quality education from an early age and encouraging lifelong learning and leisure-time cognitive engagement can help reduce dementia prevalence, particularly in highest risk, underserved communities. Public health initiatives that support both equal educational opportunities and cognitively enriching activities across the lifespan are essential components of a sustainable dementia prevention strategy in the United States.

### *The role of social determinants of health*

Educational attainment and quality are closely tied to income, employment opportunities, housing stability, access to health care, and exposure to chronic stress, all of which influence long-term brain health. These social and economic conditions shape health behaviors and exposures across the life course, ultimately affecting cognitive aging and dementia risk. Individuals with lower levels of education are more likely to experience socioeconomic disadvantages, reduced access to cognitively enriching environments, and limited health literacy, which together contribute to increased risk for cognitive decline and dementia. Importantly, disparities in educational opportunities often reflect broader structural inequities, including systemic racism and underinvestment in schools serving low-income and minority communities. Addressing these disparities through public health and policy interventions, such as improving access to high-quality early education, supporting school completion, and expanding affordable post-secondary opportunities, can help reduce inequities in cognitive aging and promote brain health across the lifespan.



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## DISCUSSION

Preclinical and clinical studies highlight the importance of cognitive enrichment in dementia risk reduction. Animal research shows that novel experiences enhance neural growth and resilience, supporting lifelong mental stimulation. In humans, higher levels of education correlate with lower dementia risk, though education quality may matter more than years of schooling. Disparities in educational access contribute to risk differences, particularly in historically underserved populations. Cognitively demanding jobs and leisure activities could reduce dementia risk by 20–40%. Cognitive training may offer benefits, but evidence from multi-domain interventions, such as the FINGER trial, which combined cognitive training with exercise, dietary guidance, and vascular risk management, suggests that a comprehensive approach may be more effective than any single component alone. Future research should refine person- and activity-specific neuroprotective factors. Public health efforts must ensure equitable education, lifelong cognitive engagement, and supportive occupational and leisure opportunities.



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