Invited Commentary

Is Cognitive Aging Predicted by Educational Level?

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A higher educational level has consistently been associated with a lower incidence of dementia. However, in the current issue of the Journal, Glymour et al. (1) present findings that are in agreement with other research in showing a lack of association between educational level and cognitive decline in the elderly. These findings are not inconsistent with the hope, yet unproven, that persons might reduce their risk of dementia by engaging in cognitively stimulating activities.

More years of education and higher cognitive abilities in youth are both generally associated with lower rates of dementia in individuals as they age (1–3). In a 2006 review, Valenzuela and Sachdev (4) showed associations to be consistent, significant in 10 of 15 studies, and strong, with an overall odds ratio of 0.53 for high educational level versus low educational level. Less certain is the association between educational level and decline in cognitive abilities. These issues have implications for the prevention of cognitive impairment.

A higher educational level has been reported to be associated with a slower decline in scores on tests of various cognitive domains (5, 6). However, Glymour et al. (7) identified a potentially substantial, nonconservative bias affecting many studies that arose from adjustment for baseline cognitive scores. Such adjustment creates an artifactual association between the baseline cognitive score and any factor that affects cognitive performance. A high score, for example, could result from either more education or a positive measurement error. As a score that is high because of measurement error will generally be associated with lower scores in subsequent testing, the bias Glymour et al. described creates the false appearance of a relation between more education and reduced cognitive decline.

Recent studies that did not include adjustment for baseline cognitive scores failed to find substantial associations between educational level and cognitive decline (8–11). Results from the article by Glymour et al. (12) in the current issue of the Journal agree. Among 4,480 residents of Dijon, France, who were 65 years of age or older, participants’ educational levels and those of their parents were strongly associated with their baseline scores on several cognitive tests, but associations with 9-year changes in scores were small and inconsistent. In their analyses, Glymour et al. (12) avoided the baseline adjustment problem, adjusted for interviewer differences and practice effects, and used weighted analyses to account for loss-to-follow-up effects. Quantile regression models showed ceiling effects for some of the standard tests studied. Ceiling effects might also incorrectly show that higher educational levels were associated with a reduced decline by making the tests insensitive to small differences in cognitive performance in high-performing persons.

Glymour et al. (12) note that in this elderly population, the average rates of decline in cognitive scores were very small (0.02–0.08 z-score units per year) compared with large education-related differences in baseline scores (0.21–0.69 z-score units). Smaller yet were the estimated effects of education on cognitive decline (0.003–0.03 z-score units per year). The authors provided an example, saying, “In the ISAAC test,” a test of category fluency, “parental educational level was associated with an initial level advantage 47 times the magnitude of the disadvantage in the rate of change (in other words, the faster rate of decline would be expected to offset the better initial position after 47 years)” (12, p. 000). They summarized the finding by stating that, “[t]he magnitude of the associations between educational background and level of cognitive performance dwarf plausible differences in rates of change” (12, p. 000). The finding was consistent: For all cognitive tests studied, education-related differences in baseline scores were large (10-fold or more) relative to...
very small and inconsistent education-related differences in changes in scores.

If a higher educational level is not substantially or consistently associated with cognitive decline, how might it prevent dementia? If, as reported, education has a large impact on pre-dementia cognitive performance, then educated persons must undergo more cognitive decline to fall to the level at which they are diagnosed with dementia. Glymour et al., as well as others, hypothesized that education may protect against dementia through “active reserve or compensatory capacity by facilitating recruitment of alternative networks after neurologic injury” (12, p. 000); for example, greater synaptic density or more active or flexible neuronal pathways might overcome some accumulating Alzheimer or cerebrovascular pathology. Alternatively, the authors suggested, education might appear to protect against dementia “because the diagnostic criteria for dementia are biased with respect to education” (12, p. 000). However, few studies have relied solely on test scores for dementia diagnosis (4), and diagnostic bias would have to be quite strong to explain an education-dementia odds ratio as strong as 0.53 (4).

What implications for the prevention of dementia can be drawn from all the recent evidence that a higher educational level is associated with lower dementia incidence (probably due primarily to some form of compensatory capacity or cognitive reserve) but not with the rate of cognitive decline? Does it affect the hope that middle-aged or older persons might prevent dementia by engaging in mentally stimulating activities? Alternatively, is one’s rate of cognitive decline determined solely by the inevitable progress of brain pathology? Like persons with higher education, those who engage in leisure activities after 65 years of age also appear to be at a reduced risk of dementia (4). However, observational studies in this age group leave questions. Did mentally stimulating activity indeed prevent dementia, or was lack of activity a result of early impairments? We do not know what cognitive activities to recommend. Furthermore, if the associations of dementia with a higher educational level or leisure time cognitive activities are due in part not to education or cognitive activities but rather to confounding by extraneous factors, for example, better diabetes or hypertension control, then cognitive activities alone may not improve cognitive performance much. More and larger randomized trials are needed (13).

The results do not argue against this hope. Cognitive activity might raise our cognitive reserve to higher levels whenever we undertake it, so that the subsequent cognitive decline takes years longer to reach the point of dementia.

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REFERENCES