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Featured Article

Transitions across cognitive states and death among older adults in relation to education: A multistate survival model using data from six longitudinal studies

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Abstract

Introduction: This study examines the role of educational attainment, an indicator of cognitive reserve, on transitions in later life between cognitive states (normal Mini-Mental State Examination (MMSE), mild MMSE impairment, and severe MMSE impairment) and death.

Methods: Analysis of six international longitudinal studies was performed using a coordinated approach. Multistate survival models were used to estimate the transition patterns via different cognitive states. Life expectancies were estimated.

Results: Across most studies, a higher level of education was associated with a lower risk of transitioning from normal MMSE to mild MMSE impairment but was not associated with other transitions. Those with higher levels of education and socioeconomic status had longer nonimpaired life expectancies.

Discussion: This study highlights the importance of education in later life and that early life experiences can delay later compromised cognitive health. This study also demonstrates the feasibility and benefit in conducting coordinated analysis across multiple studies to validate findings.

Keywords: Cognition; Dementia; Life expectancy; Education; Socioeconomic status; Multistate modeling

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1. Introduction

Increasing dementia prevalence [1,2] presents a challenge to communities and governments across the world and emphasizes the imminent need for more research to understand the cognitive aging process and the risks for transitioning from intact functioning to compromised cognitive health, dementia, and finally to death. Such research is urgently needed to inform new initiatives, including interventions.

Cognitive aging refers to a gradual decline in mean levels of cognitive abilities and is generally considered to be an unavoidable consequence of aging related processes. However, for some individuals, the rate of decline in cognitive functioning (e.g., memory) becomes noticeable and greater than what would be expected with normal aging, though not severe enough to have an impact on activities of daily living, referred to as mild cognitive impairment (MCI) [3]. Individuals with MCI are more likely to progress to dementia than the general population; however, some individuals remain in the state of MCI and do not progress to dementia while others transition to the normal range of cognitive functioning as a result of biologic and/or random variability [3–5].

Several risk factors producing substantial interindividual differences have been identified for their association with cognitive decline and dementia, including occupational attainment [6–8], education [8–12], and other life experiences [13,14]. According to a recent study, increases in educational attainment may help explain the decline in dementia prevalence in the United States [15]. Resilience to the progressive neuropathology that is associated with dementia is often referred to as cognitive reserve [16]. In some studies, the magnitude of the cognitive reserve is assumed to be related to educational attainment and cognitive engagement [8,17–21], although a wide range of risk factors and molecular markers can influence the reserve [22,23]. Several studies suggest that higher education can delay the onset of cognitive decline in individuals before the diagnosis of dementia. However, after the diagnosis of dementia, those with higher educational attainment exhibit a steeper rate of decline and lower remaining life expectancy compared with those with fewer years of education [18,24–26]. Thus, cognitive reserve appears to delay the onset of dementia, but once a critical threshold is reached, the progression of dementia in terms of effects on cognitive decline is more rapid which in turn leads to fewer years before death [19].

Evaluation of transitions to pathological cognitive states from normative cognitive aging has rarely been evaluated using population-based longitudinal data [27]. Recent advances in multistate modeling (MSM) allow for a better understanding of the role of putative risk factors in transitions between cognitive states. Furthermore, this approach allows for the estimation of overall and noncognitively impaired life expectancies. The knowledge gained from using this approach will improve our understanding of risk factor models differentiating cognitive aging and progressive dementia, potentially facilitating earlier detection for inclusion in preventative intervention aimed also to improve the quality of life of older adults and their families.

One previous study [28] used MSM to show that older adults with a higher level of education and more complex occupation were less likely to progress to a state of MCI. However, they were also more likely to transition from dementia to death. We aim to expand and assess the robustness of these findings by undertaking analyses using data from six independent longitudinal studies, permitting an opportunity to evaluate whether these results are replicated and examine cross-country generalizability. The objectives of this study are to (1) examine the relationship between education and transitions between different cognitive states (i.e., normal Mini-Mental State Examination (MMSE), mild MMSE impairment, and severe MMSE impairment) and death and (2) to estimate life expectancies for older adults with different levels of education.

2. Methods

2.1. Studies

We used data from six longitudinal studies of aging. We briefly describe each of the studies below and present baseline characteristics from each study in Table 1. Only respondents with valid data on the MMSE at baseline, information on education and socioeconomic status (SES), and two known states were included in the analysis. Death status was retrieved from death registers where respondents were living (e.g. Swedish Causes of Death Register).

2.1.1. Origins of Variance in the Oldest-Old

The Origins of Variance in the Oldest-Old (OCTO-Twin) study included dizygotic and monozygotic twin pairs aged 80 years and older [29,30]. The sample was selected from older adults in the population-based Swedish Twin Registry [31]. Five cycles of longitudinal data were collected at 2-year intervals. The initial sample consisted of 702 respondents (351 same-sex pairs) with some missing on MMSE. The final analysis included 694 respondents.

2.1.2. Longitudinal Aging Study Amsterdam

Longitudinal Aging Study Amsterdam (LASA) is an ongoing study on the functioning of older adults in the Netherlands. Details on the sampling and data collection of LASA have been published elsewhere [32,33]. A nationally representative survey was conducted in 1992/1993 among 3107 respondents between the ages of 55 and 85. Follow-up measurements are collected approximately every 3 years. For the present study, we used data from seven LASA measurement waves from 1992/1993 to 2011/2012. The final sample consisted of 2570 respondents (four missing on MMSE & 533 missing on income).