Cognitive functioning in Older Adults: A Life Span Health Production Function Approach

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Introduction

With the growing population of US older adults we should be more concerned their cognitive health, as greater longevity increases the lifetime risk of memory diseases that compromise the cognitive abilities vital to well-being:

- Cognitive impairment, the intermediate stage between cognitive decline associated with normal aging and dementia, is often related to declines in quality of life among older adults[1].
- Alzheimer's disease, thought to be the most common underlying pathology for elders' cognitive dysfunction[2], which is already the sixth leading cause of death in the US[3].
- Cognitive impairment has consequences for families, imposing caregiving burdens on family members, and generates high health care utilization costs for society[4].

Aging is a lifelong process, so too is being cognitively healthy in later life. Life-course theory postulates that our ultimate health outcomes are, in part, a response to an accumulation of advantages and disadvantages that begin early in life. The life course perspective describes a dynamic process between social status and health[5], emphasizing that personal development is a lifelong process, and such development interacts with the social environment to create trajectories of well–being[6].

The **objective** of this study is to:

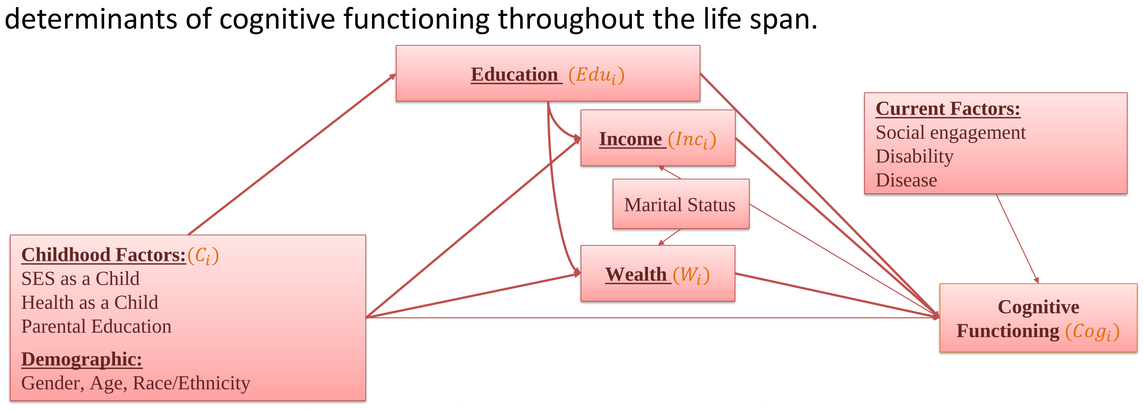
Address the associations between childhood characteristics and cognitive achievement at older age, and current factors and cognitive achievement at older age.

Quantify the direct, indirect and total effects of childhood characteristics on cognitive achievement at older age; indirect effects that operate through mid-life factors.

Explain the value of taking a life-span approach to study health and cognition in later life.

Conceptual Framework

This model shows the association between childhood factors and cognitive functioning as mediated by educational attainment, income and wealth, controlling for other determinants of cognitive functioning throughout the life span.



Cognitive achievement production function

Cognitive functioning is the output of a health production function, and it is produced over the lifecycle from childhood to early and late adulthood.

$$Cog_i = f\,(C_i, E[C_i, X_i], I[C_i, E(C_i, X_i), X_i], W[C_i, E(C_i, X_i), X_i], D_i\,, X_i)$$

Marginal products

$$\underbrace{\frac{\partial Cog_i}{\partial C_i}}_{\text{Total effect}} = \underbrace{\frac{\partial f}{\partial C_i}}_{\text{Direct effect}} + \underbrace{\left[\frac{\partial f}{\partial Edu_i} + \frac{\partial f}{\partial Inc_i}\frac{\partial I}{\partial Edu_i} + \frac{\partial f}{\partial W_i}\frac{\partial W}{\partial Edu_i}\right]\frac{\partial E}{\partial C_i}}_{\text{Indirect effect through education}} + \underbrace{\frac{\partial f}{\partial Inc_i}\frac{\partial I}{\partial C_i}}_{\text{Indirect effect through income}} + \underbrace{\frac{\partial f}{\partial W_i}\frac{\partial W}{\partial C_i}}_{\text{Indirect effect through wealth}}$$

Methods and Materials

We used 2012 Health and Retirement Study (HRS) data, which is a biennial nationally representative survey of older Americans and their spouses with extensive data on the health and functioning of participants, demographic characteristics, income and financial assets, and other data. We also used RAND-HRS, which is a clean, user-friendly version of the HRS, with derived measures for total annual income, wealth, and other key variables, publicly available to researchers

Dependent variables: Level of cognitive functioning

Measured by the score obtained on the Telephone Interview of Cognitive Status (TICS) derived from a self-responded cognition questionnaire[7]. The global measure of cognitive functioning consisted of seven items (range = 0-35): immediate word recall (10 points), delayed word recall (10 points), serial 7s (5 points), backward counting (2 points), naming the day of the week and the date (4 points), naming two objects (2 points), naming the current president and vice president of the United States (2 points).

Statistical technique

We use structural Equation Modeling and account for the complex design of the HRS by including appropriate sampling weights to ensure correct inferences and allow our findings to generalize to the population of non-institutionalized Americans in 2012, ages 65 and older.

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Results

Sample Characteristics

Variables	Mean (SD) / %
Observations	9,105
Sociodemographic	
Age	74.34 (0.152)
Female	57.20 %
Whites	82.6 %
African Americans	8.39 %
Hispanic	6.75 %
Married /partnered	58.1 %
Separated/divorced	12.8 %
Widowed	24.3 %
Childhood circumstances	
Mothers Education more than HS	40.70 %
Fathers Education more than HS	33.70 %
Childhood health (1-5)	1.750 (0.016)
Childhood SES (1-3)	2.229 (0.010)
Cognition (0-35)	21.80 (0.095)
Education (0-17)	12.82 (0.089)
Ln(income)	10.38 (0.025)
Ln(wealth)	11.67 (0.059)
Social engagement (0-5)	2.78 (0.022)
Disability (0-10)	0.59 (0.019)
Disease (0-9)	2.73 (0.021)

- Being socially engaged increases the level of cognition.
- Having major disease or disabilities are associated with lower level of cognition.
- Being female, married and white are associated with higher cognitive functioning.

Total Effects

	Coef.	Std. Err.
Ln(wealth)	0.119***	0.029
Ln(income)	0.350***	0.075
Education	0.529***	0.024
Childhood circumstances		
Childhood Health		
Excellent	0.847***	0.144
Very Good	0.414**	0.186
Fair	0.232	0.242
Poor	-0.765	0.561
Father's Education Level		
More than HS	0.750***	0.124
Mother's Education Level		
More than HS	0.775***	0.131
Childhood SES		
Above Average	0.313	0.237
Below Average	-0.090	0.108
Disability	-0.677***	0.038
Disease	-0.123***	0.038
Social engagement	0.084***	0.025
Sociodemographic		
Age cohort		
75-84	-2.046***	0.122
85+	-4.363***	0.235
Race/ethnicity		
African American	-2.980***	0.161
Hispanic	-2.628***	0.202
Other race	-1.561***	0.570
Gender		
Female	0.895***	0.127
Marital Status		
Separated/divorced	-0.274*	0.162
Widowed	-0.361	0.216
Never married	0.110	0.311

Direct, Indirect and Total Effects of Childhood Circumstances on Cognitive Functioning at Older Age

	Combined Indirect	Direct	Total
Self-rated health as a child			
Excellent	0.463***	0.384***	0.847***
Very Good	0.274***	0.141	0.414**
Fair	0.102	0.130	0.232
Poor	-0.009	-0.757	-0.765
Father's Education Level			
More than HS	0.510***	0.241**	0.750***
Mother's Education Level			
More than HS	0.563***	0.212*	0.775***
Childhood SES			
Above Average	0.538***	-0.225	0.313
Below Average	-0.264***	0.174	-0.090

Favorable childhood characteristics have positive implications for cognitive functioning at older age.

- The effects of childhood factors are manifested directly and indirectly through early- and mid-adulthood socioeconomic achievement.
- Having educated parents and good health during childhood increased cognitive functioning at older age both directly and indirectly through education, income and wealth.

Discussion

Disadvantageous SES and health circumstances:

- negative influence on biological mechanisms (e.g. through stress)
- predispose individuals to accelerated aging
- modify trajectories for social and economic success
- increase susceptibility to negative health outcomes

Socioeconomic attainments in midlife:

- usually modeled as confounders, controlled for in current studies
- either accelerate or decelerate the effects of early life conditions

This study allows for these indirect pathways:

- the findings substantiate previously published results
- the findings update the evidence using more precise estimates of these relationships

Conclusions

- Accounting for indirect effects: previous works examining the relationships between childhood conditions and cognition at older age may have underestimated childhood's effects.
- Midlife circumstances: transmitters of the imprint of childhood conditions.
- Never too late: current health and being actively engaged have important potentials for well cognitive aging.

A life-course perspective calls on policymakers and civil society to invest in the various phases of life, especially at key transition points when risks to well-being and windows of opportunity are greatest. These include critical periods for both biological and social development, including childhood, early and mid-adulthood, and current conditions as an older adult.

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