

Sustained Economic Hardship and Cognitive Function: The Coronary Artery Risk Development in Young Adults Study

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Introduction: The relationship between low income and worse health outcomes is evident, yet its association with cognitive outcomes is less explored. Most studies have measured income at one time and none have examined how sustained exposure to low income influences cognition in a relatively young cohort. This study examined the effect of sustained poverty and perceived financial difficulty on cognitive function in midlife.

Methods: Income data were collected six times between 1985 and 2010 for 3,383 adults from the Coronary Artery Risk Development in Young Adults prospective cohort study. Sustained poverty was defined by the percentage of time participants' household income was <200% of the federal poverty level—"never" in poverty, "0 < to <1/3," "≥1/3 to <100%" or "all-time." In 2010, at a mean age of 50 years, participants underwent a cognitive battery. Data were analyzed in 2015.

Results: In demographic-adjusted linear regression models, individuals with all-time poverty performed significantly worse than individuals never in poverty: 0.92 points worse on verbal memory (z-score, -0.28; 95% CI=-0.43, -0.13), 11.60 points worse on processing speed (z-score, -0.72; 95% CI=-0.85, -0.58), and 3.50 points worse on executive function (z-score, -0.32; 95% CI=-0.47, -0.17). Similar results were observed with perceived financial difficulty. Findings were robust when restricted to highly educated participants, suggesting little evidence for reverse causation.

Conclusions: Cumulative exposure to low income over 2 decades was strongly associated with worse cognitive function of a relatively young cohort. Poverty and perceived hardship may be important contributors to premature aging among disadvantaged populations.

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INTRODUCTION

Growing income inequality suggests that a large proportion of the U.S. population faces economic hardship.¹ Individuals with low income may lack appropriate resources to follow healthy lifestyles and access care, resulting in disproportionate exposure to unfavorable health outcomes. Maintaining cognitive abilities is a key component of health and daily quality of life, and previous research has shown that exposure to poor socioeconomic conditions during childhood, adulthood, or cumulatively—mostly as a summary composite score of multiple socioeconomic factors, each measured one time—is associated with cognitive deficits.²⁻¹² Yet, the majority of these studies involved

older adults and thus it remains unknown whether economic adversity influences cognitive health much

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earlier in the life course. Furthermore, most previous studies relied on a single measure of socioeconomic adversity, which has rarely been income, or have measured income at only one point in time.

Income is dynamic and individuals are likely to experience income changes in response to economic trends or shocks.^{13,14} Studies suggest that most individuals experience some sort of income mobility between young adulthood and midlife.^{13,15} Therefore, monitoring changes in income and financial difficulty over an extended period of time and how these influence cognitive health will have important implications for public health policy. To the authors' knowledge, most prior studies of income and health, especially cognitive health, have used one or two measurements of income,^{2,9-12} and thus fail to capture the effect of sustained exposure to low income on cognitive health.⁶

The study objective is to use repeated data of various economic parameters to examine the associations of sustained poverty and perceived financial difficulty on cognitive function in a cohort of young to middle-aged black and white adults of the Coronary Artery Risk Development in Young Adults (CARDIA) study.

METHODS

Study Population

A total of 5,115 adults aged 18–30 years at baseline in 1985–1986 were recruited into the CARDIA study from four field centers: the University of Alabama at Birmingham, the University of Minnesota, Northwestern University, and Kaiser Permanente (Oakland, CA). Recruitment was balanced within center by sex, age, and education. Participants were examined at baseline and at follow-up examinations 2, 5, 7, 10, 15, 20, and 25 years after baseline. Standardized protocols were used to gather demographic, social, and clinical data. Details of the study have been described elsewhere.¹⁶ Cognitive function was assessed at Year 25. The study was approved by the appropriate IRBs, and informed consent was obtained from study participants. The present analysis was approved by the Publications and Presentations committee of the CARDIA study.

Measures

Sustained poverty was defined as the percentage of times between 1990 and 2010 that participants reported total household incomes that were <200% of the federal poverty level (FPL). The 200% cut point was used in accordance with the literature.^{6,17} Owing to the dose–response relationship between income and cognition, categories were defined as: “never” in poverty, “0 < to <1/3 of the time,” “≥1/3 of the time to <100% of the time,” or “all-time.” Income data collected in 1990, 1992, 1995, 2000, 2005, and 2010 were used. More than 85% of the sample had at least five repeated income measurements. Pre-tax household income for the past 12 months from all sources was self-reported and recorded in income categories. The category midpoint was chosen as the participant's income for that year (Appendix Table 1, available online). Using

income category midpoint and family size at each examination period, Census Bureau FPL thresholds¹⁸ were then used to identify households with incomes that were <200% of the FPL for that relevant year. The income cut offs for 200% of the FPL for a four-person household were \$26,718 in 1990, \$28,670 in 1992, \$31,138 in 1995, \$35,206 in 2000, \$39,942 in 2005, and \$44,630 in 2010.

Participants also repeatedly reported, at seven of the total eight study visits, their overall perceived difficulty in paying for basics such as food and heating. More than 70% of the sample had all seven repeated measurements of financial difficulty. Responses included: *very hard*, *hard*, *somewhat hard*, or *not very hard*. For each year, these groups were dichotomized into reporting “at least somewhat hard” versus “not very hard.”¹⁵ Sustained perceived financial difficulty was calculated as the percentage of times between 1985 and 2010 that participants reported difficulty with categories of: never, 0 < to <1/3, ≥1/3 to <100%, or all-time.

At Year 25, all CARDIA participants were administered a cognitive battery that included three tests. The Rey Auditory–Verbal Learning Test (range, 0–15) measures verbal memory and assesses the ability to memorize and retrieve words, with higher score (in words) indicating better performance.¹⁹ The Digit Symbol Substitution Test (range, 0–133) is a subtest of the Wechsler Adult Intelligence Scale and measures performance on speed domains, with higher score (in symbols) indicating better performance.²⁰ The interference score on the Stroop test (executive skills) measures the additional amount of processing needed to respond to one stimulus while suppressing another. The test was scored by seconds to spell out color words printed in a different color plus number of errors, thus higher score (seconds + errors) indicates worse performance.²¹ All three tests are widely used in the literature and are sensitive to detecting cognitive aging.

The CARDIA participants reported their sex, race, years of education, their parents' years of education (highest of mother and father), and marital status. Lifetime cigarette pack years and daily alcohol use were calculated based on an interviewer-administered questionnaire. Participants reported the amount of time spent weekly in 13 categories of physical activity over the past year, and then the total amount in exercise units was calculated. BMI was calculated using measured weight and height (kg/m²). Blood pressure was measured while seated using a standard automated blood pressure monitor. Type 2 diabetes was ascertained based on fasting glucose levels ≥126 mg/dL, self-reported medication use, a 2-hour postload glucose ≥200 mg/dL, or hemoglobin A1c ≥6.5%. Symptoms of depression were assessed using the 20-item Center for Epidemiologic Studies Depression Scale.²²

For time-varying covariates, including milliliters of alcohol use, physical activity units, BMI, systolic and diastolic blood pressure, and depressive symptoms, previously published statistical techniques²³ were followed to calculate cumulative exposure as a time-weighted average of each covariate over the study period.

Statistical Analysis

Participant characteristics were assessed across categories of sustained poverty and perceived financial difficulty. Differences in means and proportions between categories of sustained poverty and financial difficulty were tested using ANOVAs and chi-square tests, respectively. Using the Year 1990 dollar, average income was illustrated at each time point between 1990 and 2010 adjusted for inflation based on the Consumer Price Index.²⁴

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