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Association between Executive Dysfunction and Instrumental Activities of Daily Living: Racial and ethnic differences among community-dwelling older adults in the Southeastern US.

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Abstract

Objective: Examining cultural differences in assessment of cognitive/ functional disability among older Americans is needed. This analysis examined associations between day-to-day function, measured by activities of daily living (ADL), and cognition, measured by CLOX scores, among older African American (AA) and non-Hispanic White (nHW) community-dwelling women and men.

Methods: *Design-* Cross-sectional *Setting-* Homes of community-dwelling older adults.

Participants- 893 Medicare beneficiaries > 65 living in west-central Alabama, without diagnoses of dementia, who were participants in the University of Alabama at Birmingham (UAB) Study of Aging, and who had complete data. *Measurements-* Physical function was assessed by self-reported ADL difficulty; cognitive function by CLOX, a clock drawing-task. Multivariable, linear regression models were used to examine associations within race/sex specific groups.

Results: After controlling for socio-demographic factors and comorbidities, CLOX1 scores were inversely and significantly correlated with ADL for AA men ($\beta=-0.205$, $P=0.003$). CLOX2 scores were similarly associated with ADL and IADL for the total group ($\beta=-0.118$, $P=0.001$, and $\beta=-0.180$, $P<0.001$, respectively); for ADL, significant associations were seen for AA men and nHW women ($\beta=-0.203$, $P=0.004$, and $\beta=-0.139$, $P=0.02$, respectively) and, for IADL, in AA women and men ($\beta=-0.156$, $P=0.03$, and $\beta=-0.24$, $P<0.001$, respectively).

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Conclusion: While African American women reported the highest difficulty with ADLs and IADLs among all race/sex groups, CLOX1 scores were correlated with ADL for AA men only. CLOX1 may have limitations to identify functional disability for older AA women.

Keywords

Executive dysfunction; IADL; Health Disparities; African Americans

1.1 Introduction

African Americans (AA) living with dementia are less likely to be diagnosed despite having significant impairments in specific instrumental activities of daily living (IADL).^{1,2} Moreover, AA with hypertension (HTN) demonstrate a greater prevalence of cognitive and functional disability compared to individuals who are not hypertensive and/ or other racial/ethnic groups.³ Recent studies suggest that AA, who have traditionally and disproportionately carried the burden of hypertensive chronic disease,⁴ continue to have higher incidence and prevalence rates as they age.⁵ Therefore identifying a culturally appropriate method to accurately and quickly identify HTN-related or vascular- cognitive and functional disability during primary care visits may be essential to improving rates of early dementia detection for older AA.

It is known that patients of all racial and ethnic groups who have dementia are often undiagnosed in primary care environments.⁶ However, lower detection among racial and ethnic older adult minorities may be due to several barriers. These barriers include language, education, and culture that potentially influences the frequency and timeliness of health-seeking behaviors, necessitating the successful development of minority-elder specific primary care-based intervention models for expedited identification and management of dementia in these special populations.⁷

One reason dementia detection rates may be low is that there is no current recommendation or guideline for screening. Repeatedly, the US Preventive Services Task Force (USPSTF) has concluded that routine screening for cognitive impairment (CI) is not warranted due to what they perceive as the unfavorable balance of costs vs. benefits.^{8,9} Moreover although the most recent guidelines acknowledge that screening improves detection rates in certain high-risk populations, still emphasized is the concern that there is insufficient evidence to effectively determine if cost and potential harms of screening justifies the modest benefit of current therapy.¹⁰ However, as in other diseases that pose differential risks for special populations (i.e. prostate cancer in AA men), older AA may experience earlier onset Alzheimer's Disease (EOAD), causing greater morbidity and burden on families and society.¹¹ Furthermore, older AAs are often undiagnosed until they have advanced disease,¹² limiting their benefit from pharmacotherapy which is most beneficial in early stages of dementia. The result is a shortened time-period to self-direct future activities, financial plans, and advance care directives.

Criteria for diagnosing "all-cause dementia" have been recently revised but still are initially based on a demonstration of impaired daily function, along with cognitive deficits including memory.^{13,14} Recent studies distinguish between a global type of dementia, which consists

of executive dysfunction and global cognitive deficits as well as features of posterior cortical degeneration (Type I), versus dementia limited to anterior cortical degeneration (Type II) and note that the prevalence of these dementia types may be different in certain racial/ethnic groups.¹⁵ However, the best way to detect these dementia types, particularly in AA, continues to be controversial.

Identifying impairments in day-to-day function has traditionally been achieved by using Activities of Daily Living (ADL) and Instrumental ADL (IADL).¹⁶⁻¹⁸ Despite recent proprietary and copyright realities,¹⁹ the Mini-Mental State Examination (MMSE) is widely used by primary-care physicians (PCPs) to screen for CI,²⁰ and also is used to infer the level of functional impairment a patient may have. However, previous analyses demonstrated that cognition as measured by MMSE was not independently correlated with self-reported daily function in either AA or non-Hispanic White (nHW) older community-dwelling men and women.²¹ Moreover, the MMSE has been explicitly demonstrated to be limited to only predict cognitive performance and not ADL performance.²² This may primarily be due to the initial diagnostic criteria of dementia which only includes intellectual deterioration with no mention of functional disability.²³

Therefore, a brief assessment that accurately identifies functional impairment correlated significantly with cognition, not solely relying on self-reported functional measures, is needed for effective detection of dementia in primary care. Given the predilection of HTN to affect areas of the brain controlling executive function, measurement of executive function may be superior to traditional memory-recall/ global performance assessments in correlating with daily function. However, we need to know whether the same types of cultural or racial/ethnic limitations exist using measurements of executive function, given that cognitive tests like the MMSE have demonstrated low specificity for detecting CI in AA.²⁴

This analysis aimed to examine if an association existed between day-to-day function measured by ADL/IADL and an executive clock drawing task.

1.2 Material and Methods

Data for the current analysis was drawn from the University of Alabama at Birmingham (UAB) Study of Aging (SOA), an observational cohort study of older adults living in community.²⁵ The SOA in-home assessments and interviews included cognitive testing, self-reported functional activity, and a detailed medical history. The protocol was approved by the UAB Institutional Review Board prior to recruitment. Study details and methods used in an analysis of a multi-item test of cognition (MMSE) and day-to-day activities has been published previously.²¹ For this cross-sectional analysis, we included only participants with complete data for CLOX, MMSE, ADLs and IADLs, and the sociodemographic covariates described in Table 1.

1.2.1 Cognition

This analysis uses CLOX scores, which provides an observable measure of higher function (i.e. planning and coordinating),²⁶ as an assessment of cognition. CLOX is a rapid measure of executive function involving a clock drawing task and therefore relevant as a tool for

expedited detection of impaired cognition for use in primary care. CLOX includes a fifteen item scoring process. The CLOX task is performed by instructing the participant to draw a clock “that says 1:45; set the hands and numbers on the face so that even a child could read them.” Instructions deliberately include distractors (e.g., hand, face) designed to confront and test for thought intrusions and errors in processing that persons may experience secondary to cognitive impairments and that might interfere with drawing. CLOX has two parts, (1) a command directed clock drawing task (CLOX1) in which the participant draws a clock using the aforementioned instructions, and (2) a copied clock (CLOX2).²⁷ CLOX1 is designed to assess executive function and CLOX2 is designed to assess posterior cortical function. The highest score attainable is 15 points. A score indicative of cognitive impairment is less than or equal to 10 for CLOX1 and 12 for CLOX2. Normative performance data of the CLOX task for the UAB Study of Aging has been previously published²⁸ providing a framework to interpret the CLOX scores in relation to impairment in executive function.

1.2.2 Function

Function was assessed during in-home assessments asking about self-reported difficulty in completing both ADL (bathing, dressing, transferring, toileting, eating, walking, getting outside) and IADL (light and heavy housework, using the telephone, preparing meals, shopping, and managing money) tasks. Each ADL or IADL task was scored as 0=no difficulty; 1=some difficulty; 2=a lot of difficulty; and 3 = unable to do the task. A composite functional difficulty score was created from the sum of the difficulty scores for the individual tasks, ranging from 0-21 for ADL and 0-18 for IADL with higher scores representing greater difficulty.

1.2.3 Other Health Measures

Comorbidity was measured by using a total count of diseases at baseline based on the Charlson Comorbidity Index (CCI)²⁹ without consideration of severity and has been described in detail in our previous published study.²¹ MMSE scores were included for the purpose of comparing performance to a conventional standard of reference. The MMSE is scored on a scale from 0-30, where scores of < 24/30 are considered consistent with CI²³.

1.2.4 Statistical Analysis

Overall and race-sex stratified characteristics for the study sample were described using means and standard deviations (SD) for continuous variables and frequencies (percentages) for categorical variables. The associations between CLOX scores and ADLs and IADLs were estimated using unadjusted and adjusted linear regression models. Coefficients of determination (R-squared) values and beta coefficients were computed for the overall sample, as well as race-sex stratified groups. Adjusted race-sex stratified models included age (65-74, 75-84, 85), education (grades 0-8, grades 9-11, high school, >high school), income (\$8,000/year, <\$8,000/year), marital status (currently married, not currently married), household size (1, 2, 3), and number of comorbidities. Overall sample models also adjusted for race (white, AA) and sex. Age-adjusted values for CLOX, ADL, and IADL scores are presented in the sample characteristics; all regression models utilize the unadjusted values. P-values were considered statistically significant at $p < 0.05$. Analyses

were performed using JMP®, Version 10 (SAS Institute Inc., Cary, NC) and the R statistical program (R Core Team, Vienna, Austria).

1.3 Results

1.3.1 Sample Characteristics

Sociodemographic and clinical characteristics and CLOX, MMSE, ADL, and IADL scores are shown in Table 1. Compared to non-Hispanic White participants, AA participants were older, less formally educated, received lower income, and more likely to be unmarried. AA participants were more likely to rate their health as fair or poor and live in households with three or more persons.

Compared to nHW participants, 67% of AA participants had MMSE scores above the normal cut off in comparison to approximately 75% of nHW with MMSE scores above the normal cut off. Regarding CLOX scores, nearly 38% of the total sample had an abnormal CLOX1 score and nearly a third of the total sample had an abnormal CLOX2 score. Additionally, CLOX scores differed by race; while nearly 50% of AA participants had low CLOX 1 and CLOX 2 scores, fewer than 40% of nHW had low CLOX1 or CLOX2 scores ($p < .001$). Interestingly, for nHW, gender differences emerged: nearly 30% of non-Hispanic White men had low CLOX1 scores in contrast to 20% of nHW women. Non-Hispanic White women had mean CLOX1 and CLOX2 scores that were the highest amongst all race/sex groups. Non-Hispanic White men reported the least difficulty with ADLs and IADLs among all race/sex groups in this community-dwelling sample.

With regard to medical conditions, hypertension (HTN) was more prevalent for AA participants; diabetes (DM) was more prevalent among AA women, Coronary Artery Disease (CAD) and Chronic Obstructive Pulmonary Disease (COPD) were most prevalent for non-Hispanic White men, hip fracture most prevalent for non-Hispanic White women and arthritis/gout most prevalent for both AA and non-Hispanic White women. For Transient Ischemic Attack (TIA) and Cerebrovascular Accident (CVA) the prevalence for the total sample was nearly 10%. African American women had the highest number of comorbidities of any other race-sex group while non-Hispanic White women had the lowest number of comorbidities.

1.3.2 Unadjusted Analyses

The independent associations between CLOX scores and ADL and IADL difficulty are shown in Table 2. The unadjusted regression model showed that CLOX1 and CLOX2 scores and ADL or IADL difficulty were inversely and significantly correlated for the total sample. Subgroup analyses indicated a significant correlation between CLOX1 and ADLs for AA men and non-Hispanic White women and between CLOX1 and IADL for AA men only. Significant correlations were also seen between CLOX2 and ADL for all race-sex groups with the exception of non-Hispanic White men and between CLOX2 and IADL for all race-sex groups.

1.3.3 Adjusted Analyses

Statistically significant inverse correlations remained in the adjusted model (Table 3) between CLOX1 scores and ADL difficulty in AA men only. IADL difficulty and CLOX1 were not significantly associated. CLOX2 and ADL and IADL showed a significant association for the total group, seen for AA men and women (nHW women-ADL, AA women-IADL).

1.4 Discussion

This study contributes to the understanding of the relationship between specific aspects of cognition, as measured by CLOX assessment, and day-to-day activities among community-dwelling older adults in specific race and sex groups. It also begins to describe the difference in executive function among a diverse community-dwelling older population.

Our findings support those of previous clock-drawing phenotype studies where AA were shown to demonstrate a greater prevalence of ‘type 1’ dementia such as Alzheimer’s disease.¹⁵ In the current analysis, AA demonstrated both lower mean CLOX 1 scores (executive function measurement) as well as a greater prevalence of CLOX 1 performance impairment, or executive dyscontrol (Table 1). This was coupled with greater prevalence of CLOX 2, or posterior cortical impairment. Greater prevalence in the impairment of both executive function and posterior cortical function results in a greater prevalence of Type 1 dementia.

While AA men had lower mean CLOX1 scores than any other race/sex group, AA women self-reported the highest difficulty with ADLs and IADLs among all race/sex groups in this community-dwelling sample. This self-reported impairment in IADL for AA women is consistent with findings from the Women’s Health and Aging Study in which executive attention was associated with performance on IADLs thought to be secondary to difficulties in “flexibly planning and initiating a course of action”.³⁰ It could be that a more detailed assessment of executive function (e.g., Wisconsin Card Sort),³¹ might be more strongly associated with IADL function and other complex daily activities in AA women. However, such measures require more time than is available in a typical primary care clinic setting and require additional and specialized training to administer properly. Alternatively, dysfunction in self-reported IADLs may not be as robust a measure of functional impairment and a different objective functional measure may be more appropriate (e.g. a physical performance measure like gait speed).

Measuring executive function can serve as a brief cognitive measure more closely aligned with every day functional performance as it measures higher-level cognitive skills and abilities like organizing (planning, sequencing, problem solving) and regulating (monitoring internal and external stimuli, initiation of action, self-control).³² Executive dyscontrol also has more direct clinical implications including being associated with reduced treatment adherence.³³

Finally, any effective assessment measure needs to be administered quickly to be practical in the primary care setting. The CLOX method of measuring executive function has been used in busy primary care practices as a screen for cognitive impairment and takes less than two

minutes for a trained administrator.³⁴ A clock drawing task is also included in the Mini-Cog, now incorporated as a screening instrument for memory impairment in the Annual Wellness Visit.³⁵ While ease and speed of administration make CLOX an attractive method for assessing cognition in primary care, potential cultural/educational limitations needed to be evaluated.

Our results indicated that CLOX may have some limitation in identifying functional disability for older AA women. These analyses do not indicate potential reasons, but further research should include analyses of the association of CLOX with more complex daily tasks and/or observed performance measures (e.g., Everyday Cognitive Battery (ECB) in which a participant's ability to balance a check book and/ or complete a 'pill box' set up is evaluated).³⁶ Alternatively, our functional measures of ADL, obtained via self-report by study participants, could contribute unmeasured confounding (given no objective performance measure of daily function), affecting the significance of results; this could also potentially explain the small magnitude of association identified via minimal β values. However, measuring function using ADL, uses functional measures that have been established in the literature for over 40 years.

Our investigation also may be limited by our sample population focus on older adults from Alabama and therefore may not be generalizable to a more general US population. Study participants also were assessed via in-home assessment and therefore the sample may actually represent a more frail population than that recruited from clinic sites or other research centers. Additionally, due to the cross-sectional design there may have been confounding variables that were not captured or measured possibly leading to unmeasured confounding. Whether executive function as a correlate of daily function, has more impact in younger samples is a focus of current work.

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1.5**Implications**

While our study is limited to identifying associations between executive function, ADL and IADL, it is an important investigation identifying functionally relevant assessment tools that can be quickly administered and have broader utility in a variety of primary care environments. CLOX seems to be significantly associated with day –to-day function in AA men in particular and could be used as a quick assessment of whether more time and resources should be assigned to more fully assess cognitive impairment. Given that the original data set was over sampled to include AA and males, this study was powered to identify associations in AA populations. Further research should be directed to identify and test whether other measures of executive function have limited associations with observed functional performance measures for AA women.

Key points: (1) Description of the prevalence of executive dysfunction among older African Americans and non-Hispanic Whites (2) Association between executive dysfunction measured by CLOX and day-to-day activity measured by Basic and Instrumental Activities of Daily Living (ADLs and IADLs).

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Table 1.

Description of study sample

Characteristic	African American		White		Total Sample
	Male, N=216	Female, N=207	Male, N=233	Female, N=237	N=893
Age, n (%)					
65-74	114 (52.7)	110 (53.1)	135 (57.9)	129 (54.4)	488 (54.6)
75-84	82 (37.9)	71 (34.3)	80 (34.3)	87 (36.7)	320 (35.8)
85	20 (9.2)	26 (12.5)	18 (7.7)	21 (8.8)	85 (9.5)
Education, n (%) ^c					
Grade 0-8	104 (48.1)	82 (39.6)	34 (14.5)	22 (9.2)	242 (27.1)
Grade 9-11	46 (21.3)	47 (22.7)	32 (13.7)	46 (19.4)	171 (19.1)
High School	28 (12.9)	53 (25.6)	71 (30.4)	68 (28.6)	220 (24.6)
>High School	38 (17.5)	25 (12.0)	96 (41.2)	101 (42.6)	260 (29.1)
Income, \$/y, n (%) ^c					
8,000	164 (75.9)	106 (51.2)	222 (95.2)	204 (86.0)	696 (77.9)
<8,000	52 (24.0)	101 (48.7)	11 (4.7)	33 (13.9)	197 (22.0)
Currently married, n (%) ^c	131 (60.6)	42 (20.2)	186 (79.8)	110 (46.4)	469 (52.5)
Household size, n (%) ^c					
1	60 (27.7)	80 (38.6)	39 (16.7)	105 (44.3)	284 (31.8)
2	99 (45.8)	84 (40.5)	172 (73.8)	114 (48.1)	469 (52.5)
3	57 (26.3)	43 (20.7)	22 (9.4)	18 (7.5)	140 (15.6)
Mini-Mental State Examination score ¹ (/30)					
Mean ± SD	24.9 ± 5.0	24.5 ± 4.8	24.9 ± 4.6	25.5 ± 4.6	25.0 ± 4.8
23, n (%)	67 (31.0)	69 (33.3)	69 (29.6)	57 (23.9)	262 (29.3)
24-30, n (%)	149 (69.0)	138 (66.7)	164 (70.4)	180 (75.9)	631 (70.7)
CLOX score ² (/15)					
Mean ± SD, CLOX1	9.1 (3.3)	9.5 (3.1)	11.2 (2.9)	11.7 (2.3)	10.4 (3.1)
Mean ± SD, CLOX2	11.7 (2.8)	11.7 (2.5)	13.2 (1.6)	13.5 (1.2)	12.6 (2.2)

Characteristic	African American		White		Total Sample N=893
	Male, N=216	Female, N=207	Male, N=233	Female, N=237	
CLOX1 ³ 10 ^c	115 (53.2)	107 (51.6)	68 (29.1)	48 (20.2)	338 (37.8)
CLOX2 ⁴ 12 ^c	102 (47.2)	102 (49.2)	51 (21.8)	34 (14.3)	289 (32.3)
Medical conditions, n (%)					
Hypertension ^c	160 (74.0)	179 (86.4)	134 (57.5)	156 (65.8)	629 (70.4)
Transient ischemic attack or stroke	26 (12.0)	17 (8.2)	23 (9.8)	17 (7.1)	83 (9.2)
Chronic Obstructive Pulmonary Disease ^c	36 (16.6)	10 (4.8)	48 (20.6)	29 (12.2)	123 (13.7)
Diabetes mellitus ^c	49 (22.6)	70 (33.8)	54 (23.1)	40 (16.8)	213 (23.8)
Coronary Artery Disease ^c	38 (17.5)	32 (15.4)	80 (34.3)	28 (11.8)	178 (19.9)
Arthritis or gout ^b	95 (43.9)	109 (52.6)	90 (38.6)	129 (54.4)	423 (47.3)
Hip fracture	4 (1.8)	1 (0.4)	4 (1.7)	7 (2.9)	16 (1.7)
Number of comorbidities, mean $\pm$ SD	1.8 $\pm$ 1.2	2.0 $\pm$ 1.1	1.8 $\pm$ 1.3	1.7 $\pm$ 1.1	1.8 $\pm$ 1.2
Difficulty with Daily Activities					
Mean $\pm$ SD, Activities of Daily Living ⁵ (ADL) ^b	1.2 (2.4)	1.9 (2.57)	1.1 (2.01)	1.4 (2.44)	1.4 (2.37)
Mean $\pm$ SD, Instrumental Activities of Daily ⁶					
Living (IADL) ^c	1.8 (3.3)	2.3 (3.08)	1.1 (1.88)	1.8 (2.51)	1.7 (2.76)
Fair or poor self-rated health, n (%) ^c	107 (49.5)	110 (53.1)	87 (37.3)	78 (32.9)	382 (42.7)

^a $P < .05$ ^b .01^c .001. SD=standard deviation.¹ Mini-Mental State Examination total score is out of 30 points.² CLOX total score is out of 15 points.³ CLOX 1 score of 10 or less suggests executive function impairment.⁴ CLOX 2 score of 12 or less suggests posterior cortical impairment.

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ADL (Basic Activities of Daily Living) Scores range from 0-21 where higher scores mean more difficulty.
IADL (Instrumental Activities of Daily Living) Scores range from 0-18.

Unadjusted model coefficients for CLOX1 and CLOX2 with ADL and IADL difficulty in African –American and non-Hispanic White women and men

Table 2.

Participants	CLOX1				CLOX2			
	Unstd. ⁷ β	Std. ⁸ β	P	Adj. ⁹ R ²	Unstd. β	Std. β	P	Adj. R ²
ADLs								
Total group	-0.084	-0.109	0.001	0.012	-0.192	-0.182	<.001	0.033
AA women	-0.009	-0.011	0.87	0.0001	-0.137	-0.136	0.05	0.018
White women	-0.141	-0.135	0.04	0.018	-0.544	-0.264	<.001	0.069
AA men	-0.168	-0.231	<.001	0.053	-0.218	-0.247	<.001	0.061
White men	-0.014	-0.020	0.76	0.0004	-0.088	-0.068	0.30	0.004
IADL								
Total group	-0.135	-0.151	<.001	0.022	-0.315	-0.256	<.001	0.065
AA women	-0.111	-0.110	0.11	0.012	-0.284	-0.234	<.001	0.055
White women	-0.115	-0.107	0.10	0.011	-0.449	-0.212	0.001	0.045
AA men	-0.186	-0.184	0.006	0.034	-0.372	-0.310	<.001	0.096
White men	-0.074	-0.113	0.08	0.012	-0.156	-0.129	0.05	0.016

⁷ Unstandardized

⁸ Standardized

⁹ Adjusted

Table 3.

Adjusted model coefficients for CLOX1 and CLOX2 with ADL and IADL difficulty in African –American and non-Hispanic White women and men

Participants	CLOX1			CLOX2			P	Adj. R ²
	Unstd. B	Std. β	P	Unstd. β	Std. β	P		
ADLs								
Total group ^a	−0.022	−0.028	0.42	0.135	−0.125	−0.118	0.001	0.145
AA women ^b	0.061	0.073	0.34	0.092	−0.102	−0.101	0.19	0.096
White women ^b	−0.050	−0.047	0.42	0.241	−0.287	−0.139	0.02	0.257
AA men ^b	−0.149	−0.205	0.003	0.100	−0.176	−0.203	0.004	0.098
White men ^b	0.024	0.034	0.60	0.100	−0.048	−0.037	0.58	0.100
IADL								
Total group ^a	−0.041	−0.046	0.18	0.167	−0.221	−0.180	<.001	0.190
AA women ^b	0.007	0.007	0.92	0.178	−0.190	−0.156	0.03	0.197
White women ^b	−0.011	−0.010	0.86	0.215	−0.193	−0.091	0.14	0.223
AA men ^b	−0.105	−0.104	0.13	0.142	−0.289	−0.240	<.001	0.183
White men ^b	−0.037	−0.056	0.40	0.082	−0.119	−0.098	0.14	0.088

^aCoefficients adjusted for age, race, sex, education, income, marital status, number in household, and number of comorbidities.^bCoefficients adjusted for age, education, income, marital status, number in household, and number of comorbidities.