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The role of Southern context in shaping life course exposures linked to dementia incidence for Black and White older adults in the United States

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Abstract

While racial inequities in dementia risk are well-documented in the United States, research has paid less attention to role of US Southern context in shaping dementia risk through life course exposures. In this study, we examine how Southern birth and Southern residence in adulthood are linked to dementia incidence for Black and White older adults in the United States. Using the Health and Retirement Study ($N = 15{,}613$), we estimate a series of hazard models to evaluate how life course risk factors such as childhood health and social disadvantage, education, adult socioeconomic status, health behaviors, and cardiometabolic conditions impact the association between Southern life course residency and dementia risk. We find different patterns in how Southern life course context shapes dementia risk among Black and White adults, with dementia risk among Blacks especially sensitive to combinations of Southern life course context. These findings demonstrate the importance of considering potential heterogenous life course pathways to cognitive aging and health that may be shaped by larger socio-historical experiences.

Keywords Life course, Dementia, Race, Southern context, U.S.

Introduction

Black older adults aged 65 years and older experience a significantly greater burden of dementia than White older adults in the United States, with 2 to 3 times higher dementia prevalence and more years of life lived with dementia [11, 20, 27, 30]. These two components alone point to greater care and medical needs among Black older adults, placing disproportionate demands on individual, family, and community support systems. Racial differences in dementia risk, however, are highly malleable. Prior research has shown the importance of a wide variety of modifiable risk factors, such as education, occupational attainment, health behaviors, in influencing dementia risk [42, 43]. Racial disparities in cognitive health have been attributed to some of these differences, but further research is needed to understand how and why these factors may differentially impact cognitive health in later life for Blacks and Whites.

Racial differences in cognitive health are structured by systemic racism. Prior research has shown that race disparities in cognitive impairment incidence were significantly reduced after accounting for early life conditions and educational attainment, highlighting the importance of early life development [64]. However, the trajectory

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of life course that are associated with later life cognitive health are unlikely to be uniform across racial groups, which can cloud our understanding of the life course origins of the cognitive health of Black and White older adults. A burgeoning area of research has shown how trajectories of life course exposures and the associations of exposures with later life health are shaped along sociodemographic lines, due to the ways that social and economic opportunities vary across the life course by race, gender, and social class [5, 7, 54, 55].

One important way that life course exposures may be shaped differently for Black and White older adults is the larger social context. Recent research has highlighted the role of state and regional contexts in shaping later life health outcomes [22, 23, 31, 45]. For example, being born in the South has been linked to increased disability and mortality risk [22, 23, 47]. However, the association of the South on later life health outcomes most likely differs for Black and White older adults. After Reconstruction and before Civil Rights legislation in the mid-twentieth century, Black Southerners lived under Jim Crow regimes that enforced racial segregation across multiple facets of social, political, and economic life that limited political representation and social mobility, while creating an environment that permitted, if not supported, interpersonal and institutional violence. Not surprisingly, because of differences in Jim Crow exposures, the association of the South with later life health among Black older adults is expected to differ from the health of White older adults.

This study uses the Health and Retirement Study (2000–2016), a nationally representative data of older adults 65+, to evaluate how Southern birth and Southern adult residence are linked to dementia risk and whether differences of life course exposures within each racial group may help account for the association between Southern context and the risk of dementia. To do so, we examine within each racial group the association between Southern birth and adulthood residence on dementia risk. We then assess how specific life course risk factors may attenuate the association between Southern birth and adult residence with dementia risk. Understanding how context may shape individual level exposures and trajectories of exposures for the two large racial groups in the United States is a useful strategy to derive a more in-depth understanding how life course origins of cognitive health in later life are influenced by racialization processes.

Background

While prior work has provided insight into the malleability of Black-White disparities in cognitive health by tying racial differences to social and economic risks found throughout life [24, 51–53, 64], fewer studies have investigated how life course exposures and their risk may differ across racial groups due to social stratification centered around race in the United States. Life course research provides insight into understanding how early life circumstances, such as poverty and educational attainment, are related or combine with more adulthood factors, such as adult socioeconomic wellbeing or cardiometabolic conditions to influence later life cognitive health risk [9, 34, 35, 61]. Broadly, understanding race-specific life course origins of aging and health can also yield additional insight into the ways that social environments and health risks are influenced by macroenvironmental contexts that not only create different life course "risk profiles," but also potentially different exposure trajectories. For example, in this study, Southern context provides an effective example to examine racial differences in life course trajectories given the organization of political, legal, economic, social, and cultural institutions centered around racial classification, leading to what some scholars have argued the creation of an "American caste system" in which Black Americans were treated as second-class citizens and are afforded fewer opportunities and experience greater risks [4, 60]. As such, the association between Southern context and increased dementia risk will most likely be attributed to different types of life course risks for Black and White older adults that are influenced by social and economic organization centered around race.

In fact, prior research has found racial differences in specific risk factors with cognitive health in older adulthood. For example, an association between childhood BMI and Alzheimer's disease risk was found for Black older adults, but no association was found for White older adults [7]. This indicates that the links between BMI and adult cognitive health may not be a clear biological pathway, but rather structured by race in the causes and consequences of having greater BMI levels. Additionally, the association of education with cognitive functioning and health may also vary by race/ethnicity. While research has established that education yielded greater declines in life expectancy with dementia for Black older adults than for Whites older adults[20], other studies have shown almost no heterogeneity in the effect of education on semantic memory and executive functioning, but some differences in verbal episodic memory [18]. Altogether, these studies point to the growing importance in evaluating how risk factors may differ across racial groups that, in turn, may shape within group heterogeneity differently.

In the general population, Southern context has been tied to elevated rates of dementia and other morbidities that are risk factors for dementia [3, 32, 41, 64]. In fact, a recent study found that Southern birth, regardless of adulthood residence, was associated with greater

mortality risk [26]. However, the association between race and Southern context likely differs due to the different types of social environments created in the South (i.e. Jim Crow legislation). Racial differences in the contextual associations with cognitive health in later life have important implications for understanding how life course trajectories of exposures may influence health among Black and White older adults.

The association of being born or living in the South with later life health has important implications for understanding health in two notable ways. First, over 80% of Black older adults were born in the South, whereas approximately 30% of White older adults were born in the South. Therefore, when evaluating health of the Black older adult population in the United States, the influence of Southern context on aging and health may be even more important to consider. Second, Jim Crow legislation in the South lead to broad disenfranchisement on the basis of race, creating a "racial caste" system in which Black people were treated as second-class citizens across economic, social, political, and cultural institutions [4, 60]. For example, this disadvantage has been shown through educational attainment. While Black older adults had fewer educational opportunities throughout the U.S. as evidenced by lower levels of completed schooling [13], Black people who attended school in the South had the lowest level of education of any race/region group [28]. Therefore, while the South may be associated with worse cognitive health for both Black and White older adults, the impact on cognitive health for Black people may go above and beyond the lower levels of educational attainment or other known risk factors due to the ways that Jim Crow created divergent realities based on race classification. This study advances research in this area by evaluating race-specific life course origins of cognitive health and how exposures and trajectories may be tied to Southern context.

Additionally, the association of the South with cognitive health in older adulthood should also consider racial differences in internal migration patterns that shaped childhood and adulthood exposures and opportunities. Specifically, during the Great Migration (1870–1970), over 6 million black children and adults left the South. While out-migration from the South did not eliminate exposure to discrimination, Black people who left the South had significantly different occupational and employment opportunities, going from largely agrarian-based livelihood to blue-collar industrial work [1, 14]. As such, those who left the South may have had different social and economic exposures than those who remained in the South, which may lead to heterogeneity in exposures and trajectories of exposures to later life cognitive health. Additionally, it is also important to note that Black older adults who left the South are a "select" group of individuals with regard to their education and health profiles [8, 14, 58]. Therefore, both selection and differences in exposures related to context may have contributed to notable differences in how Southern context at different parts of the life course shape cognitive health risks. This study evaluates directly how the combinations of Southern birth and adulthood residence are associated with dementia risk, and whether life course exposures may explain these associations.

Methods

Data

We use the Health and Retirement Study (HRS) from 2000 to 2016 to evaluate race-specific life course exposures are associated with dementia incidence. The HRS is a biannual, nationally representative longitudinal survey of older adults in the United States. It collects extensive information on socioeconomic conditions, health behaviors, and cognitive health, including retrospective information on early life conditions. It also includes both community-dwelling and institutionalized respondents, which is crucial to documenting and analyzing dementia because institutionalized respondents disproportionately represent a large share of older adults living with dementia. Additionally, we also include respondents whose cognitive information was collected from proxies. Proxies are important to include because over half of dementia incidence cases in the HRS are based on proxy reports. This inclusion is fundamental for these analyses because respondents who needed proxy reports are more likely to have severe cognitive impairment. Lastly, the HRS also oversamples older Black adults which allows us to evaluate how life course factors are associated with dementia risk within the Black population.

In total, we have 2,573 non-Hispanic Black and 13,040 non-Hispanic White adults who were 65 years or older and provided at least two consecutive waves of information from 2000 to 2016. These samples are used to construct "person-year" data, which is the basis for estimating the discrete-time hazard models for dementia risk. In total, we had 9,990 and 57,285 person-years of observation for Black and White older adults. Additionally, we had 2,398 dementia events – defined as a change from not having dementia to have dementia between observation waves— for non-Hispanic Whites and 894 for non-Hispanic Blacks. Our samples are limited to respondents 65 years and older because the cognitive status criteria were not validated on a younger adult population (more information on the cognitive status criteria is provided below). Additionally, our analytical samples are limited to wave information following the 2000 wave because

consistent cognitive information had not been available in prior waves for both proxy and self-respondents. Approximately 5% of the sample had missing information from any of the life course risk factors used in this study (most missing information came from childhood variables that were collected from retrospective reports). These respondents were excluded from the analytical sample.

Measures

Dementia onset

The onset of dementia was identified when a respondent experienced a change in cognitive status between two consecutive observation waves from "not having dementia" to "having dementia." Cognitive status classification is based on the Langa-Weir approach, which has been widely used to evaluate dementia status in the U.S. population [15–17, 20, 30, 37, 38]. The Langa-Weir criteria was specifically developed for the HRS and validated based on a subset of the HRS respondents, known as the Aging, Memory, and Demographic Study (ADAMS), who were clinically evaluated [15, 16].

The Langa-Weir classification integrates proxy reports and self-respondent measures to identify cognitive status for both community dwelling and institutionalized respondents. Proxy measures were collected from HRS respondents who are unable to participate in the HRS cognitive assessment, which may in part be attributable to underlying physical or cognitive health issues. Proxy information was primarily collected from spouses/partners or children. The proxy measure was based on three criteria: 1) proxy-report rating of respondent's current memory from excellent to poor (0–4), 2) whether respondent had limitations in instrumental activities of daily living which include using the phone, managing money, taking medication, preparing hot meals, and shopping for groceries (0–5), and 3) an interviewer assessment of difficulty in completing the interview due to cognitive limitations (0–2). In total, the proxy score ranged from 0 to 11 with scores of 6 or greater coded as having dementia. For HRS self-respondents, dementia status was assigned based on a summary score of cognitive performance using the HRS modified Telephone Interview for Cognitive Status (TICS) examination. The cognitive summary measurement consisted of four parts: 1) immediate word recall of 10 words (0–10), 2) delayed word recall of 10 words (0–10), 3) 5 trials of serial 7 s (0–5), and backward counting from 20 (0–2). In total, the score ranged from 0 to 27 with scores 6 or lower classified as having dementia. A small percentage of respondents refused to participate in serial 7 subtraction or immediate and delayed recall. To retain these cases, we used imputed scores provided by the HRS RAND P file [48].

Life course exposures

Southern life course birth and adult residence

Southern life course residence was based on region of birth and region of residence at first observation in the HRS. This measurement approach allows us to identify four residential categories: Southern birth and Southern residence in adulthood, Southern birth and non-Southern residence in adulthood, non-Southern birth and southern residence in adulthood, and non-Southern birth and non-Southern residence in adulthood.

Childhood conditions

To assess other early life effects, we rely on retrospectively self-reported information on childhood health and socioeconomic adversity. Child health was based on the following question: "Consider your health while you were growing up, before you were 16 years old. Would you say that your health during that time was excellent, very good, good, fair, or poor?". Following prior research that showed high validity and reliability [29], we dichotomized childhood health: 1- fair/poor and 0 - good/very good/excellent.

Childhood socioeconomic adversity was based on a summary measure that ranged from 0 to 5. Higher scores indicate higher levels of childhood socioeconomic adversity. The summary measure comes from self-reported retrospective questions: if their family had to move due to financial circumstances, their family was financially well off, mother had less then 8 years of education, father had less than 8 years of education, and father had a blue-collar job. Missing information on mother's or father's education was imputed to be below 8 years of education. Prior research has shown a strong association between missingness and low levels of education [44, 46]. Additionally, prior research using this measure has shown a dose–response association with disability incidence [46]. The variables were combined in this way to show level of socioeconomic adversity in childhood and association with dementia risk.

Education

Education was based on the highest credential obtained: less than high school or GED, high school, and some college or more. GED has been categorized with less than high school because recent education-health studies have found greater similarity between respondents with GEDs to respondents without a high school diploma than to respondents with a high school diploma [63]. College

education has been collapsed into one broad category because of significant data limitations that would not allow for a more detailed evaluation of college degree holders (only 42 dementia events were observed for Black older adults with a college degree).

Broadly, the international equivalency for the categories of education used in this study are as follows: less then high or GED indicates incompletion of secondary school (of which most adults in the U.S. complete primary school but may leave a year or two before the completion of secondary school), high school diploma would indicate completion of secondary schooling, and some college or more would indicate some exposure to tertiary schooling (or university levels) but not include trade school or other apprenticeship-like program. Equivalency varies widely across countries; therefore, any substantive or direct comparison should consider specific-country contexts.

Adult socioeconomic conditions

We used net household wealth information to account for later life adult socioeconomic status. The wealth measure was adjusted to account for household size. Following prior work, we added a constant to eliminate non-zeros and negative numbers, which were then logged and divided by square root of total in the household size [46]. Additionally, the wealth measure was adjusted for inflation, using the CPI index, to allow for comparability across years. Wealth information was taken from RAND HRS Version P, which provided imputed values for respondents who did not provide full information.

Health behaviors

Our analysis incorporates three common adult health behaviors that are known risk factors for dementia: smoking, drinking, and obesity [40, 49, 50, 62]. Smoking status is categorized into never smoked, previous smoker, and current smoker. Drinking behavior is based on the based on the self-reported number of drinks during a given week. Respondents were classified as non-drinkers, moderate drinkers (less than 7 drinks a week), and heavy drinker (more than 7 drinks a week). Using CDC standard of Class 2 obesity or higher, obesity was dichotomized into below or above 35+ BMI. All three measures are time varying.

Adult health conditions

We included four cardiometabolic health conditions (high blood pressure, cardiovascular disease, stroke, and diabetes) that are significantly associated with dementia risk. These conditions are self-reports of a doctor's diagnosis. These are also time-varying across waves.

Controls

All models control for age, sex, and marital status. Age was a continuous variable. Sex was dichotomous (0 = male, 1 = female). Marital status had four categories: single, never married, married, divorced, or widowed.

Analytical plan

To examine race-specific life course origins of dementia incidence, we use a series of multivariate, discrete-time hazard models that estimate the risk of dementia onset. Clusters of covariates are systematically added to evaluate the sensitivity of Southern context across the life course to dementia risk. A decrease in the risk associated with Southern life course residence between models signifies that part of the risk may be attributed to the inclusion of other life course determinants (or combination of risk factors). We use race-stratified modeling to allow covariates to be freely estimated for each racial group and for ease of interpretation. Conceptually, the basic models for both race groups are as follows:

Model 1: Southern Birth and Southern Adult Residence
Model 2: Model 1 + Childhood Health and Adversity
Model 3: Model 2 + Education
Model 4: Model 3 + Adult Socioeconomic Conditions
Model 5: Model 4 + Health Behaviors
Model 6: Model 5 + Cardiometabolic Health Conditions

Each of these models evaluates the association with covariates on the transition from not have dementia to having dementia. The transition rate is calculated using the following equation:

$$\mu_{ij}(t) = lim \frac{P_{ij}(t,n)}{n} as\ n \to 0$$

μ_{ij} refers to the transition rate in the t^{th} interval from not having dementia (i) to having dementia (j), P_{ij} represents the probability of transitioning from state i (i.e., no dementia) to state j (i.e., dementia) during the observation interval from t to $t+n$, assuming the individual was in state i at age t. We assume that dementia risk is constant within the exposure interval but can vary across intervals based on age. Death and loss to follow up were treated as unobserved right censoring events. Hazard models were estimated using the *streg* command in Stata 16.1.

In addition to the main analysis, we also evaluated how potential selection processes may influence our results. We estimated logistic regression models of dementia status at first observation (a prevalence model summarizing baseline associations), using the same covariates presented in the main results (shown in the Table 4). All models were estimated using STATA 15.3.

Results

Life course descriptive results

Table 1 shows analytical sample characteristics derived from respondent's first observation. Results are presented for Black and White respondents; we also provide results for those who were and weren't born in the South for reference.

Table 1 Descriptive Statistics at Baseline for Black and White Older Adults, Health, and Retirement Study ($N = 2,573$ and $N = 13,040$, respectively)

	Non-Hispanic White			Non-Hispanic Black		
	Total	**Born in the South**	**Born Outside of the South**	**Total**	**Born in the South**	**Born Outside of the South**
		29.79	**70.22**		**82.2**	**17.8**
% Child and Adult Residence						
Born in South & South in Adulthood	24.9			54.6		
Born in South & Not South in Adulthood	4.6			27.4		
Not Born in South & Not South in Adulthood	58.2			14.9		
Not Born in South & South in Adulthood	12.4			3.2		
% Summary Measure of Childhood Disadvantage						
0	40.5	32.5	43.6	19.2	16.9	30.5
1	22	20.1	23.2	18.9	17.7	25.9
2	21.5	24.9	19.9	28.4	28.7	23.9
3	11	14.3	9.5	21	23.1	12.2
4	4.2	6.6	3.2	9.2	10	5.7
5	0.8	1.5	0.5	3.3	3.4	1.7
% Poor Childhood Health	5.8	7.1	5.1	7.7	8	7
% Education Completion						
LTHS	22.3	30.8	18.3	44.5	48.5	27.7
High School	34.5	31.1	36	25.7	25.5	25.8
Some College or more	43.2	38	45.6	29.7	25.6	46.8
Mean and Standard Deviation of Wealth (Logged, adjusted for Household Size)	13.4 (0.9)	13.4 (.9)	13.5 (.9)	13.2 (0.9)	13.3 (.8)	13.6 (.9)
% Smoking Status (Ref: Current Smoker)						
Current Smoker	13.1	14.6	11.9	17.9	23.7	15.9
Former Smoker	45.5	41.9	47.3	42	42.6	40.7
Never Smoked	41.4	43.4	40.8	40.1	41.4	35.5
% Obese (35 + BMI)	7.8	7	8.4	15.6	15.6	15.7
% Cardiometabolic Conditions						
Heart Condition	23.7	25.9	23.1	21.1	21.2	18.9
High Blood Pressure	49.3	52.1	48.5	69.6	70.9	65.6
Stroke	7.6	8.6	7.3	10.4	10.7	8.1
Diabetes	14.8	16.3	14.2	26.6	26.7	29.4
Controls						
% Marital Status						
Married	69	67.1	69.7	47.9	48.4	47.7
Divorced/Separated	8.7	9.1	8.4	19.7	18.5	23.5
Widowed	19.8	21.9	19.4	27	28.1	22.9
Never Married	2.4	1.9	2.5	5.3	5	5.9
Mean and Standard Deviation of Age	69.2 (7.4)	69.1 (7.2)	69.8 (7.5)	67.85 (7.1)	68.5 (7.2)	66.8 (6.1)
% Male	43	41.3	44	37.8	37.8	38.3

Most Black older adults were born in the South and remained in the South during adulthood (54.6%), followed by born in the South and moved outside of the South in adulthood (27.4%), not born in the South and outside the South in adulthood (14.9%), and born outside the South but lived in the South during adulthood (3.2%). Overall, patterns show the importance of Southern context for Black respondents: over 80% of Black respondents were born in the South with a large proportion leaving the South. Patterns for non-Hispanic White older adults markedly differed. For non-Hispanic White older adults, the majority were not born in the South and did not reside in the South in adulthood (58.2%), followed by Born in the South and living in South in adulthood (24.9%), not born in the South but living in the South in adulthood (12.4%), and born in the South and moved outside of the South in adulthood (4.6%).

Childhood socioeconomic conditions and health show significant variation for both racial groups, with Black older adults reporting greater socioeconomic adversity and worse childhood health. For Black respondents, the larger proportion reported having 2 disadvantages (28.4%), followed by 3 adversities (21.0%), 0 adversities (19.2%), 1 adversity (18.9%), 4 adversities (9.2%), and 5 adversities (3.3%). 7.7% of Black respondents reported having poor childhood health. For White older adults, the largest proportion reported no childhood disadvantage (40.5%), followed by 1 disadvantage (22%), 2 disadvantages (21.5%), 3 disadvantages (11%), 4 disadvantages (4.2%), and 5 disadvantages (0.8%). 5.8% of White older adults reported poor childhood health.

Educational attainment was also reported for each group. 44.5% of Black respondents reported less than high school (LTHS), 25.7% received a high school diploma, 29.7% had some college or greater. For White respondents, 22.3% had LTHS, 34.5% received a high school diploma, 43.2% had some college or greater.

For household adjusted logged wealth, Black respondents had 13.2 and White respondents had 13.4.

For health behaviors, a majority of Black and White respondents were either non-smokers or formers smokers. 15.6% of Black older adults and 7.8% of White older adults were classified as having a BMI greater than 35+. For Black respondents, 21.1% reported having a heart condition, 69.6% reported having high blood pressure, 10.4% reported having a stroke, and 26.6% reported having diabetes. For White respondents, 23.7% reported having a heart condition, 49.3% reported having high blood pressure, 7.6% reported having a stroke, and 14.8% reported having diabetes.

Most Black and White respondents were married (47.9% and 69.0%, respectively). The average age was 67.6 for Black older adults and 69.2 for White adults.

Race-specific life course exposures and dementia incidence

We used race-stratified models to investigate race-specific life course exposures and dementia onset. Results for non-Hispanic Black respondents are shown in Table 2. When compared to all other life course residency combinations, we found the highest risk of dementia for Black respondents who were born in the South and lived in the South during adulthood. For example, compared to those born in the South and living in the South during adulthood, being born in South and living outside of the South in adulthood was associated with a lower risk of dementia onset (HR 0.721, $p < 0.001$). For those who were not born in the South, we observed an even lower risk of dementia (HR 0.547, $p < 0.001$ for those born outside the South and lived outside the South in adulthood and an HR 0.480, $p < 0.01$ for those who born outside the South and lived in the South during adulthood).

Next, we added childhood socioeconomic adversity and childhood health to assess whether the association between life course residence and dementia incidence was attenuated (see Model 2). Despite childhood socioeconomic adversity having a positive association with dementia incidence, the parameter estimates for the life course residency measures were largely unchanged. We also did not find a statistically significant association between childhood health and dementia incidence.

In Model 3, we introduced education. As expected, greater levels of education were associated with lower risk of dementia incidence. Additionally, after the inclusion of education, childhood adversity was no longer associated with dementia onset, providing some evidence that part of the association between childhood adversity with dementia onset may be educational attainment. Additionally, we observed a small attenuation of risk associated with life course residence. Respondents who left the South after birth or were not born in South still had a lower risk of dementia onset, but their advantage was slightly reduced from prior models (HR 0.721 in Model 1 vs. HR 0.804 in Model 3, but in post-hoc tests this difference was not found to be a statistically significant); the lower risk for the other life course residency categories were also reduced.

In Model 4, we added information on household wealth. We did not find any association between wealth and dementia onset. All prior parameter estimates remained largely unchanged. In Model 5, smoking status and BMI were introduced. The life course residence remained unchanged. Nevertheless, we found a lower risk of dementia for Black respondents who never smoked. In Model 6, we assessed the impact of cardiometabolic conditions on dementia risk. We only found a strong association between stroke and dementia onset (HR 1.278, $p < 0.01$). High blood pressure, diabetes, and heart

Table 2 Hazard Ratios of Hazard Models Predicting Dementia Onset for Non-Hispanic Black Older Adults by Southern Life Course Exposure and Life Course Covariates, Health and Retirement Study (2000–2016)

Variables	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	HR	95%CI	HR	95%CI	HR	95%CI	HR	95%CI	HR	95%CI	HR	95%CI
Southern Birth and Adulthood Residence (Ref: Born in South, Residing in South)												
Born South & Not in South in Adulthood	0.721***	(0.620,0.838)	0.747***	(0.642,0.870)	0.804**	(0.690,0.936)	0.804**	(0.690,0.936)	0.803**	(0.689,0.935)	0.804**	(0.690,0.937)
Not Born in South & Not in South in Adulthood	0.547***	(0.429,0.699)	0.593***	(0.463,0.760)	0.695**	(0.542,0.892)	0.695**	(0.542,0.891)	0.682**	(0.532,0.876)	0.692**	(0.539,0.889)
Not Born in South & South in Adulthood	0.480*	(0.264,0.874)	0.537*	(0.294,0.979)	0.656	(0.360,1.198)	0.656	(0.359,1.197)	0.644	(0.353,1.176)	0.649	(0.355,1.185)
Summary Measure of Childhood Disadvantage (Ref: 0)												
1			1.062	(0.825,1.367)	0.956	(0.742,1.232)	0.956	(0.742,1.232)	0.95	(0.738,1.225)	0.935	(0.725,1.204)
2			1.425**	(1.143,1.778)	1.155	(0.923,1.446)	1.157	(0.925,1.449)	1.149	(0.918,1.438)	1.122	(0.895,1.406)
3			1.395**	(1.110,1.753)	1.102	(0.873,1.391)	1.104	(0.874,1.393)	1.099	(0.870,1.387)	1.078	(0.853,1.361)
4			1.383*	(1.042,1.836)	1.093	(0.819,1.457)	1.096	(0.822,1.462)	1.085	(0.813,1.448)	1.068	(0.800,1.426)
5			1.364	(0.904,2.057)	1.042	(0.689,1.577)	1.043	(0.689,1.578)	1.025	(0.677,1.552)	1.02	(0.673,1.545)
Poor Childhood Health			1.209	(0.968,1.509)	1.229	(0.985,1.535)	1.229	(0.984,1.534)	1.223	(0.979,1.527)	1.241	(0.994,1.551)
Education Completion (ref: LTHS or GED)												
High School					0.653***	(0.552,0.772)	0.650***	(0.550,0.769)	0.651***	(0.551,0.771)	0.650***	(0.549,0.769)
Some College or more					0.390***	(0.315,0.484)	0.388***	(0.313,0.482)	0.389***	(0.314,0.483)	0.392***	(0.316,0.486)
Wealth (Logged, adjusted for Household Size)							1.037	(0.945,1.139)	1.04	(0.947,1.142)	1.034	(0.941,1.136)
Smoking Status (Ref: Current Smoker)												
Former Smoker									0.908	(0.728,1.133)	0.889	(0.712,1.110)
Never Smoked									0.787*	(0.626,0.991)	0.771*	(0.612,0.972)
Obese (35 + BMI)									1.034	(0.849,1.259)	0.999	(0.819,1.220)
Cardiometabolic Conditions												
Heart Condition											0.905	(0.777,1.055)
High Blood Pressure											1.1	(0.926,1.306)
Stroke											1.278**	(1.067,1.532)
Diabetes											1.146	(0.991,1.324)
Controls												
Marital Status (Reference: Married)												
Divorced/Separated	0.842	(0.680,1.043)	0.853	(0.688,1.057)	0.85	(0.686,1.053)	0.85	(0.686,1.054)	0.831	(0.670,1.031)	0.83	(0.669,1.029)
Widowed	1.057	(0.894,1.249)	1.055	(0.892,1.247)	0.974	(0.823,1.153)	0.976	(0.824,1.155)	0.963	(0.813,1.140)	0.958	(0.809,1.135)
Never Married	1.079	(0.781,1.490)	1.075	(0.778,1.484)	0.989	(0.716,1.365)	0.989	(0.716,1.365)	0.97	(0.702,1.341)	0.959	(0.693,1.327)
Age	1.046***	(1.037,1.055)	1.043***	(1.034,1.052)	1.039***	(1.030,1.048)	1.039***	(1.030,1.048)	1.041***	(1.032,1.051)	1.042***	(1.032,1.052)
Male	1.062	(0.915,1.232)	1.055	(0.909,1.225)	0.999	(0.860,1.160)	0.998	(0.859,1.159)	0.956	(0.817,1.117)	0.957	(0.818,1.120)

* < .05, ** $p < .01$, *** $p < .001$

disease were not statistically associated with increased risk of dementia. After accounting for chronic diseases, the associations with life course residence and education remain unchanged, providing evidence that the association between life course residency and dementia risk was not attributable to differences in disease profiles.

The results for White respondents are presented in Table 3. Those who were born outside the South, regardless of adulthood residence had a lower risk of dementia; respondents born outside the South and who lived outside South in adulthood had an approximately 27% lower risk of experiencing dementia onset (HR 0.729, $p < 0.001$). Those born outside the South and who lived in the South in adulthood had 36% lower risk (HR 0.642, $p < 0.001$). Those born in the South and who lived outside the South in adulthood were not statistically significantly different than those who were born in the South and remained in the South in adulthood.

In Model 2, childhood conditions were added. Childhood socioeconomic adversity was associated with increased risk of dementia onset, increasing with every level of adversity (HR of 1.137 for 1 adversity to HR 1.850 for 5 adversities, $p < 0.001$). Poor childhood health was also associated with an increased risk of dementia (HR 1.361, $p < 0.001$).

Next, we evaluated the association between education and dementia risk in Model 3. As expected, we found a strong decline in risk of dementia onset with higher levels of educational attainment. Compared to respondents without a high school diploma (or had a GED), respondents with a high school diploma had 44% lower risk of dementia onset (HR 0.567, $p < 0.001$), and respondents with some college or more had 57% lower risk (HR 0.438, $p < 0.001$). After including education, childhood adversity at every level is no longer associated with dementia onset. We also found that the advantage of being born outside the South decreased slightly, but was not found to be statistically significant in post-estimation tests.

In Model 4, we accounted for differences in wealth. Greater household wealth was associated with a decreased risk of dementia (HR 0.920, $p < 0.01$). However, the prior covariates were not sensitive to the inclusion of wealth. This result provides evidence that, for White respondents, socioeconomic status in adulthood adds another risk to dementia onset that does not appear to be closely tied to the increased risk dementia onset for early life conditions or educational attainment.

In Model 5, we introduced obesity and smoking status into the models. Only smoking status has a significant association with dementia risk. Respondents who no longer were smoking (former smokers) and respondents who never smoked had about a 25% lower risk of dementia onset (HR 0.758 and HR.751 at $p < 0.001$, respectively) than current smokers. However, the inclusion of smoking status and obesity does not impact the associations with previously included covariates. This showed that health behaviors explain very little in terms of differences in risk by Southern life course residence or education.

The final model (Model 6) introduces health conditions. As expected, health conditions are associated with a greater risk of dementia. Heart conditions, stroke, and diabetes are all associated with greater dementia risk. However, the associations between dementia and all previously included covariates remained largely unchanged. This finding suggests that dementia risk reflects an accumulation of risk factors across the life course. The results in Table 3 show that life course risk factors accumulate to impact dementia risk in later life, and while there are some similarities with Black respondents (Table 2), important differences in patterns provide some evidence of that life course exposures may differentially impact cognitive health risk for Black and White older adults.

Results from the logistic regression models predicting dementia status at first observation are shown in Table 4. We examined the association between life course risk factors and dementia at first observation to partly observe how selection factors may be impacting our incidence estimates. Respondents who were classified as having dementia at first observation were omitted from the incidence analysis because they not at risk of dementia onset during the observation period. We found that the same life course risk factors that predicted dementia onset also predicted dementia status at first observation, providing evidence that selection factors do not appear to drastically alter the patterns shown in these analyses.

Lastly, race-specific cumulative dementia incidence functions for each life course Southern residence category are presented in Fig. 1. First, we found notable differences in the associations of Southern residence with dementia incidence across racial groups. For Black older adults, contextual differences are evidence: Black older adults born in the South and who live in the South have the highest incidence rates across all ages, followed by those who were born in the South but lived outside of the South in adulthood. In fact, on average, the incidence rates for Black older adults born in the South and live outside of the South reach the similar levels of dementia incidence as those were born in the South and live in the South about 10 years later. Black older adults born outside the South, regardless of adulthood residence, have the lowest incidence rates and are similar to each other. For White older adults, the differences in incidence are substantially more compressed at the younger ages, with faster increases in incidence among those who born in the South compared to those who were born outside of

Table 3 Hazard Ratios of Hazard Models Predicting Dementia Onset for Non-Hispanic White Older Adults by Southern Life Course Exposure and Life Course Covariates, Health and Retirement Study (2000–2016)

Variables	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	HR	95%CI	HR	95%CI	HR	95%CI	HR	95%CI	HR	95%CI	HR	95%CI
Southern Birth and Adulthood Residence (Ref: Born in South, Residing in South)												
Born South & Not in South in Adulthood	1.011	(0.838,1.220)	1.006	(0.834,1.214)	1.066	(0.884,1.287)	1.067	(0.884,1.287)	1.071	(0.887,1.292)	1.060	(0.878,1.280)
Not Born in South & Not in South in Adulthood	0.729***	(0.665,0.799)	0.760***	(0.693,0.834)	0.811***	(0.739,0.890)	0.811***	(0.739,0.890)	0.814***	(0.742,0.894)	0.838***	(0.763,0.920)
Not Born in South & South in Adulthood	0.642***	(0.555,0.743)	0.675***	(0.583,0.781)	0.763***	(0.659,0.884)	0.761***	(0.657,0.881)	0.758***	(0.654,0.879)	0.771***	(0.665,0.893)
Summary Measure of Childhood Disadvantage (Ref: 0)												
1			1.137*	(1.015,1.274)	1.037	(0.925,1.163)	1.032	(0.921,1.157)	1.035	(0.924,1.161)	1.034	(0.922,1.159)
2			1.232***	(1.105,1.375)	1.013	(0.905,1.133)	1.004	(0.897,1.124)	1.008	(0.900,1.128)	0.998	(0.892,1.117)
3			1.388***	(1.221,1.577)	1.084	(0.950,1.237)	1.076	(0.943,1.227)	1.081	(0.948,1.234)	1.070	(0.938,1.221)
4			1.504***	(1.259,1.796)	1.132	(0.944,1.357)	1.124	(0.938,1.347)	1.134	(0.946,1.359)	1.125	(0.939,1.349)
5			1.850***	(1.290,2.653)	1.307	(0.909,1.879)	1.295	(0.900,1.862)	1.290	(0.897,1.856)	1.320	(0.918,1.898)
Poor Childhood Health			1.361***	(1.174,1.578)	1.254**	(1.081,1.454)	1.251**	(1.079,1.451)	1.255**	(1.082,1.455)	1.223**	(1.054,1.419)
Education Completion (ref: LTHS or GED)												
High School					0.561***	(0.508,0.619)	0.567***	(0.513,0.626)	0.571***	(0.517,0.630)	0.581***	(0.526,0.642)
Some College or more					0.428***	(0.386,0.476)	0.438***	(0.394,0.487)	0.443***	(0.398,0.493)	0.457***	(0.411,0.509)
Wealth (Logged, adjusted for Household Size)							0.920**	(0.869,0.975)	0.922**	(0.871,0.977)	0.927**	(0.875,0.982)
Smoking Status (Ref: Current Smoker)												
Former Smoker									0.758***	(0.651,0.883)	0.750***	(0.644,0.874)
Never Smoked									0.751***	(0.643,0.877)	0.755***	(0.646,0.882)
Obese (35 + BMI)									0.835	(0.691,1.010)	0.777**	(0.641,0.941)
Cardiometabolic Conditions												
Heart Condition											1.106*	(1.016,1.205)
High Blood Pressure											0.993	(0.911,1.082)
Stroke											1.547***	(1.397,1.713)
Diabetes											1.280***	(1.158,1.414)
Controls												
Marital Status (Reference: Married)												
Divorced/Separated	1.122	(0.943,1.334)	1.107	(0.930,1.316)	1.077	(0.906,1.282)	1.070	(0.900,1.273)	1.038	(0.872,1.237)	1.030	(0.864,1.227)
Widowed	1.212***	(1.097,1.339)	1.191***	(1.078,1.316)	1.122*	(1.015,1.240)	1.114*	(1.007,1.231)	1.100	(0.995,1.217)	1.090	(0.986,1.206)
Never Married	1.286	(0.976,1.695)	1.264	(0.959,1.667)	1.262	(0.957,1.664)	1.247	(0.946,1.644)	1.247	(0.946,1.644)	1.280	(0.971,1.688)
Age	1.093***	(1.087,1.099)	1.091***	(1.085,1.097)	1.090***	(1.084,1.096)	1.090***	(1.084,1.097)	1.092***	(1.086,1.098)	1.089***	(1.082,1.095)
Male	1.108*	(1.014,1.212)	1.095*	(1.002,1.197)	1.074	(0.981,1.175)	1.077	(0.984,1.178)	1.068	(0.973,1.173)	1.034	(0.941,1.136)

*$p < .05$, **$p < .01$, ***$p < .001$

Table 4 Odds Ratios of Logistic Regression Models Predicting Dementia Status at First Observation for Non-Hispanic Black and Non-Hispanic White older adult by Southern Life Course Exposure and Life Course Covariates, Health and Retirement Study (2000–2016)

Variables	Non-Hispanic White		Non-Hispanic Black	
	OR	95%CI	OR	95%CI
Southern Birth and Adulthood Residence (Ref: Born in South, Residing in South)				
Born South & Not in South in Adulthood	0.750	(0.479,1.176)	0.691*	(0.513,0.933)
Not Born in South & Not in South in Adulthood	0.569***	(0.461,0.703)	0.511**	(0.312,0.836)
Not Born in South & South in Adulthood	0.370***	(0.251,0.545)	1.014	(0.412,2.495)
Summary Measure of Childhood Disadvantage (Ref: 0)				
1	1.021	(0.765,1.363)	1.135	(0.681,1.892)
2	1.178	(0.903,1.537)	1.191	(0.750,1.892)
3	0.961	(0.697,1.326)	1.085	(0.670,1.756)
4	1.019	(0.660,1.572)	1.294	(0.745,2.246)
5	1.387	(0.594,3.236)	2.076*	(1.019,4.233)
Poor Childhood Health	0.977	(0.677,1.409)	1.387	(0.898,2.144)
Education Completion (ref: LTHS or GED)				
High School	0.464***	(0.370,0.583)	0.423***	(0.302,0.592)
Some College or more	0.282***	(0.215,0.369)	0.183***	(0.114,0.291)
Wealth (Logged, adjusted for Household Size)	0.821**	(0.718,0.938)	0.943	(0.805,1.105)
Smoking Status (Ref: Current Smoker)				
Former Smoker	1.063	(0.747,1.512)	1.037	(0.703,1.529)
Never Smoked	1.082	(0.755,1.552)	1.096	(0.733,1.639)
Obese (35 + BMI)	0.974	(0.634,1.496)	0.843	(0.563,1.263)
Cardiometabolic Conditions				
Heart Condition	1.096	(0.894,1.343)	1.216	(0.898,1.646)
High Blood Pressure	0.851	(0.700,1.036)	0.934	(0.694,1.257)
Stroke	3.560***	(2.830,4.478)	2.095***	(1.472,2.981)
Diabetes	1.488**	(1.164,1.903)	1.031	(0.762,1.396)
Controls				
Marital Status (Reference: Married)	1.401	(0.950,2.067)	0.781	(0.520,1.171)
Divorced/Separated	1.256	(0.991,1.593)	0.956	(0.687,1.330)
Widowed	2.165**	(1.250,3.750)	1.197	(0.672,2.134)
Never Married	1.113***	(1.099,1.128)	1.093***	(1.073,1.114)
Age	1.130	(0.905,1.412)	1.148	(0.853,1.546)
Male				

* $p < .05$, ** $p < .01$, *** $p < .001$

the South. In fact, for White older adults, the incidence curves for who were born in the South are indistinguishable from each other.

Discussion

Southern context is linked to increased dementia risk, but the relationship is not uniform for Black and White older adults in the United States. The racial differences in the association between Southern context and dementia risk may be shaped by race-based discriminatory practices during the Jim Crow South, which greatly impacted childhood experiences for Black older adults. This study sought to document how life course risk factors connect Southern birth and adulthood residence to dementia risk differently across racial groups. For Black older adults, we found substantial population heterogeneity, with the distinct combinations of Southern residency in childhood and adulthood having an important role. For White older adults, Southern birth, not adulthood residency, was associated with increased dementia risk. The more limited heterogeneity among White older adults in comparison to Black older adults likely reflects racial differences in "push" and "pull" migration factors that shape life course exposures related to dementia risk. For both groups, the exposure to the South in childhood and adulthood was modestly attenuated by life course risk

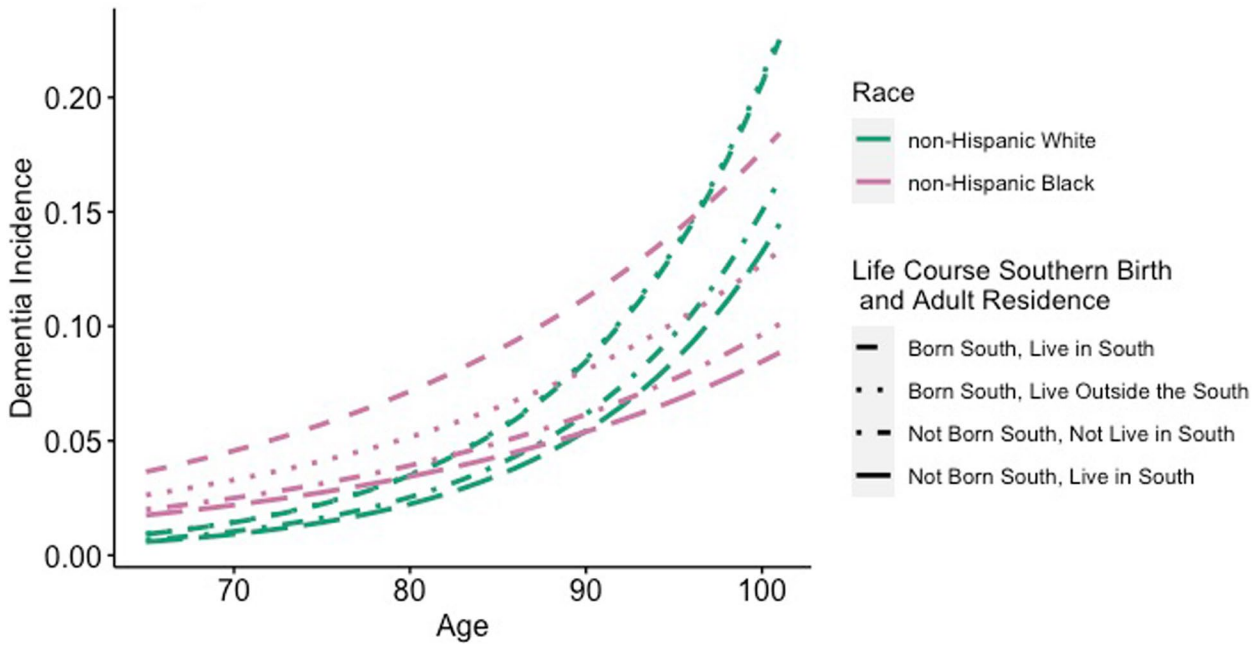

Fig. 1 Age-specific of dementia incidence risk for non-Hispanic Black and Non-Hispanic White Older Adults by Being Born in the South and Southern Residence in Adulthood, HRS 2000-2016

factors but remained strongly associated with dementia risk even after accounting for known life course risk factors for cognitive health, pointing to the importance of considering other contextual factors that may be driving risk differently for both groups. Altogether, differences in the associations of life course exposures point to the importance of considering how the racial stratification system shapes risks and rewards across lifetimes to impact later life cognitive health.

While prior research has found a strong association between Southern context and poor later life health [3, 26, 32, 36], researchers have often neglected to evaluate differences in Southern context for Black and White older adults in the United States. For Black older adults, stringent, legally codified discriminatory practices during Jim Crow curtailed economic, social, and political participation. Additionally, over 80% of Black older adults in this nationally representative sample were born in the South, making Southern context during childhood a fundamental factor in understanding later life health for the Black population in the United States. In contrast, for White older adults, race-based discriminatory practices were not operating to curtail economic, social, and political inclusion, and only 28.5% of the White sample were born in the South. These differences alone necessitate a careful examination of how Southern context impacts later life health differently across race group. In fact, in our study, we found significant differences across the associations between Southern context and dementia risk, providing evidence that context risk factors may operate differently due to the ways that large macrosocial environments shape racial inequalities.

Additionally, the explanatory factors that link Southern birth and adulthood residency to later life health may differ across health outcomes. Prior research that compared mortality risk among Black people born in the South and stayed in the South during adulthood to those who left found that Black older adults who left had greater mortality risk [8]. Explanations for the greater risk were attributed to unhealthy behaviors that were associated with improved economic conditions (i.e., being able to afford cigarettes). In contrast, our study found that Black older adults who left the South had lower dementia risk. Differences between health outcomes and Southern context may be attributed to the etiology of the disease (or health conditions, more broadly). For cognitive health, childhood operates a fundamental period in which cognitive skills and functioning develop and are carried forward into adulthood, which then lowers risk of cognitive impairment in older adulthood [19, 65]. Black older adults who are born in the South but left may have had better chances of completing greater levels of schooling (depending on their age of out-migration) or obtained more cognitively stimulating jobs [6]. In this study, we did not find that educational attainment, adult health behaviors, adult SES, or adult health conditions explained the association, but instead points to the importance how evaluating larger contexts may impact

cognitive development and aging throughout life. Further investigation with more detailed contextual and lifetime information is needed to understand health risk differences between Black Southerners who remained and migrated, and whether it may be attributed to different stages of the life course. It is also important to note that this study is unable to evaluate the heterogenous experiences of the Jim Crow South that may have varied by state, urban/rural, and other local socioeconomic contexts. Future research should collect more detailed data on lived experiences of Black older adults during the Jim Crow period that may (1) elucidate potential variation across local contexts with the larger Jim Crow macroenvironment and (2) evaluate how structural racism shaped risks and opportunities that influenced cognitive health decades later.

Differences in how life course exposures are associated with dementia risk highlight the importance of early life in understanding racial disparities in later life cognitive health. Prior research evaluating cognitive impairment differences between Black and White adults has attributed much of the difference to early life risk factors [64]. This study builds on this prior work to show that the importance of early life on cognitive health disparities may be, in part, attributed to differences in life course exposures. For example, in this study, we show a notable difference in cardiometabolic health conditions and dementia risk across racial groups. Whereas for Whites heart condition, stroke, and diabetes are associated with greater risk of dementia, for Blacks, only stroke has a positive association. Therefore, after adjusting for early life conditions and educational attainment, further adjustments for adulthood risk factors will do little to impact disparities since it is not associated with greater dementia risk for Black older adults after the inclusion of risk factors occurring prior to older adulthood. However, it is important to note these findings do not cast doubt on the association between cardiometabolic conditions and later life cognitive health and should not be interpreted that way. Rather, these results emphasize the importance of early life in understanding cognitive health within race/ethnic groups and health disparities, especially as it relates to cognitive development opportunities in early life. Relatedly, it is also important to note that this study is strengthened by using population-based survey data that includes an oversample of Black older adults. Prior research has shown that Black and Hispanic older adults are less likely to be diagnosed with dementia than White older adults even though these racial/ethnic groups are shown to have increased risk that starts at earlier ages [10, 12, 21, 25, 39]. Differences in diagnosis for non-White and White populations are likely due to systemic differences in access to care, presentations of symptoms, and, potentially, other forms of bias in evaluation [12]. By using population-based survey data, we are some circumvent these limitations associated with clinical-based data to evaluate the links between life course exposures and dementia risk for racially minoritized populations.

Relatedly, racial differences in the consequences of life course exposures, especially as they relate to Southern residency, provide evidence that the life course origins of dementia risk are dynamic. The associations found between social and economic conditions with dementia may be influenced by larger macro social forces, such as institutional racism and discrimination. For Black older adults, the increased risks associated with Southern birth and adulthood residence are most likely tied to a combination of social and economic conditions that are structured by institutional racism and discrimination. These same ties cannot be directly applied to Whites. But this association will also change with historical developments. For example, in future cohorts, the associations of Southern birth and cognitive impairment may not be as great due to spending less, or no time, under Jim Crow regimes. In fact, prior work has shown that Black older adults who spent more time in childhood in desegrated schooling had better cognitive functioning than those who had more minimal exposures at the outset of desegregation efforts following Brown v. Board [2, 51, 53]. And, in the 2000 wave, Black older adults would have spent at minimum 30 years in the Jim Crow South – which will substantially decrease in future cohorts. Therefore, in evaluating the role of *place* in later life health, race-specific models are critical in understanding how differences in historical contexts over the life course shape health and health disparities.

While our study contributes to the life course origins of dementia, some limitations should be acknowledged. First, HRS study design limits our ability to determine the number of years individuals spent in the South in either childhood or adulthood. Nevertheless, we still found significant differences among Black older adults by Southern birth and adulthood residency. Future research should investigate how timing of migration and duration of exposure may impact dementia risk, and whether it is tied to educational attainment or quality, or other adulthood factors. Second, it is important to note that the association of Southern context was not fully accounted for. While our analysis included major social and economic pathways, several other factors such as policy context and culture may also be shaping the association. Third, left truncation from survival to 2000 may impact our analytical sample. As a result, our findings may be conservative as those who survived may be more select. Lastly, the life course associations shown in this research are suggestive of potential biological mechanisms but are

not indicative of them. Previous work found that dementia risk is likely affected from several pathways: brain development, cognitive reserve, inflammation, infection and other biological processes [33, 56, 57, 59]. These processes impact an individual's cognitive performance in later life. Future work should examine how these processes combine to impact later life cognitive health, and whether they may differ across race/ethnic groups.

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None to report.

Authors' contributions
Mateo P Farina designed the study, wrote the original draft, edited the draft, and performed the analysis. Mark Hayward provided comments on methodology and analysis and edited the manuscript. Eileen M Crimmins provided feedback on study design and edited the manuscript.

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Data availability
Data for this study are available to the public through the Health and Retirement Study website: https://hrs.isr.umich.edu/data-products.

Declarations

Ethic approval and consent to participate
The Health and Retirement Study is a publicly available dataset managed by the University of Michigan. The University of Michigan obtains and maintains IRB approval along with acquiring consent from participating respondents.

Consent for publication
Not applicable. Consent for publication is given at initial enrollment of participants into the Health and Retirement Study. Respondents are informed that their responses may be used in research and will be publicly available.

Competing interests
The authors declare no competing interests.

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