Structural racism in school contexts and adolescent depression:
Development of new indices for the National Longitudinal Study of
Adolescent to Adult Health and beyond

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\textbf{ABSTRACT}

Racial discrimination is an important predictor of racial inequities in mental and physical health. Scholars have made progress conceptualizing and measuring structural forms of racism, yet, little work has focused on measuring structural racism in social contexts, which are especially relevant for studying the life course consequences of racism for health. Using the National Longitudinal Study of Adolescent to Adult Health, we take a biosocial, life course approach and develop two life stage-specific indices measuring manifestations of structural racism in school contexts in adolescence, a sensitive period of development. The first is a school contextual disadvantage index (CDI), which captures differences in resources and opportunities across schools that have been partly determined by socio-historic structural racism that has sorted Black students into more disadvantaged schools. The second is a school structural racism index (SRI), which measures differences in resources and opportunities between Black and white students within schools. Then, we relate these indices to adolescent depressive symptoms. We find that among both Black and white students of both genders, higher CDI levels are associated with more depressive symptoms. However, Black students are twice as likely to be in schools with a CDI above the median compared to white students. We also find that, controlling for the CDI, the SRI is positively associated with depressive symptoms among Black boys and girls only. Finally, the CDI and the SRI interact to produce a pattern where the likelihood of depressive symptoms increases, but only among Black boys and girls in low-disadvantage schools. These findings underscore the importance of measuring structural racism in social contexts in multifaceted ways to study life course health inequities.

\section{1. Introduction}

Racial discrimination consistently predicts racial inequities in health outcomes, including depression, anxiety disorder, hypertension, blood pressure, cancer, poor birth outcomes, and all-cause mortality (Goosby et al., 2015; Lewis et al., 2015; Williams et al., 2019). The bulk of the research linking racial discrimination and health has focused on the level of personally-mediated behaviors and attitudes, entailing, for instance, discriminatory actions against those of another race leading to devaluation (James, 2020). In recent decades scholars have made progress in theorizing and conceptualizing structural and systemic forms of racism; however, methods of measuring structural racism are still being established (Groos et al., 2018). Given its ubiquity across social systems and social interactions, and the need to bound measures by historical context, domain, space, and time to operationalize it, there is not a single measure to encompass structural racism (Groos et al., 2018; Krieger, 2014). While many scholars have compiled measures of structural racism in particular domains or geographic spaces and related them to health outcomes (Groos et al., 2018), few scholars have measured structural racism in social contexts, a level of aggregation...
relevant to understanding life course health and development.

Using the National Longitudinal Study of Adolescent to Adult Health, we take a biosocial, life course approach and measure the manifestations of structural racism in school contexts during adolescence, a sensitive period of development. To do so, we develop two indices that measure manifestations of structural racism across multiple domains at the school contextual level. First, we develop a contextual disadvantage index that captures variation across schools in absolute student resources and opportunities. We conceptualize this index as capturing, in part though by no means exclusively, manifestations of structural racism attributable to socio-historic structural racism that has concentrated Black students into more disadvantaged schools. Second, we generate a structural racism index that compares the relative balance of resources and opportunities between Black and white adolescents, capturing manifestations of structural racism within schools. Then, we investigate whether these indices predict adolescent depressive symptoms independently and interactively using Wave 1 survey data.

2. Background

2.1. Structural racism theory and measurement

By one definition, structural racism can be understood as embedded in the interconnected policies, practices, and norms that enable the operation of systemic racism across political, legal, economic, school, and other societal systems (Braveman et al., 2022). This suggests structural racism can be measured as variation or inequities in structures, systems, and institutions, or their manifestations, that produce racially disparate outcomes. Indeed, most work aimed at quantitatively measuring structural racism has aggregated individual-level measures in various domains and at different geographic levels, or within a specific institution. For example, scholars have compared Black and white populations across indicators in multiple state-level domains, e.g., political, economic, and educational, and have used such indicators to create a structural racism index (Brown & Homan, 2022; Lukachko et al., 2014; Mesic et al., 2018). Others have examined the relationship between health outcomes and structurally racialized county-level characteristics or county-level structural racism indicators such as the opportunity for economic mobility, the racial dissimilarity index, and the Black-white ratio of felony incarceration (Chambers et al., 2018; Hargrove & Gaydosh, 2022). Still, others have used residential segregation as a manifestation of historically racist policies and practices (Krieger, 2014; Kershaw et al., 2015). However, this work has tended to overlook or obscure social contexts as places in which structural racism is manifested and operates, despite the relevance of social contexts to understanding health (Visser et al., 2021).

In Bonilla-Silva’s conceptualization of structural racism, social systems are hierarchically structured by race and differentially distribute rewards accordingly. Moreover, the structure is comprised of the aggregate of social relations and practices based on racial distinctions. This perspective more explicitly links macro-structures to individuals and emphasizes social contexts as important places in which structural racism is reified (Bonilla-Silva, 1997). We build on this perspective also noting that race discrimination structures social contexts and the social connections that occur within them to influence health (Umberson & Montez, 2010). The race discrimination system is also comprised of interlinked subsystems, such that racial disparities are interdependent and mutually reinforcing across subsystems (e.g., education systems, housing markets, labor markets) (Reskin, 2012). This suggests that the impact of racialized social interactions that comprise a social context will not be limited to that context. Indeed, racialized rules are thought to organize racist everyday practices – and hence interactions – across institutions (Gee & Hicken, 2021). Taking these perspectives together, social contexts, as primary places of social interaction, are relevant domains for measuring manifestations of structural racism even when the root causes of those manifestations may have occurred outside of that context or domain. Further, ecocultural theory suggests that structural racism in social contexts will benefit racially dominant groups as compared to racially minoritized groups, leading to disparities in resources and opportunities that are embodied and manifested as health inequities (Krieger, 2012).

Understanding structural racism in social contexts across specific life stages presents an important complement to the more common measures of geographic context, as it elucidates the relationship between racial inequities and health through a life course lens. For example, a biosocial perspective suggests that health is a result of bidirectional interactions of social factors, which are often stratified at multiple levels, and biological factors across the life course. This perspective conveys that social contexts change across the life course and that the timing of exposure to these contexts is important to the development of human health (McDade & Harris, 2018). This suggests that measuring structural racism in the social contexts most relevant at a particular developmental life stage may be central to understanding its contribution to inequities in life course health.

As individuals progress through the life course, they are exposed to different, potentially discriminatory, institutions that overlap with specific sensitive periods of development, during which they may be particularly vulnerable to adversity and social experiences (Gee et al., 2019). Thus, it is important to conceptualize and test indicators of structural racism specific or most relevant to a given stage of the life course. We argue that manifestations of structural racism within school contexts align well with the adolescent stage of development. We, therefore, introduce measures of structural racism that manifest at the school level and examine their association with adolescent depressive symptoms.

2.2. Structural racism in adolescent school contexts

School and family contexts are among the most important contexts for child and adolescent wellbeing, with schools becoming more influential as children develop (Parcel, Dufur and Cornel Zito 2010). Adolescents spend a considerable amount of time in school, which can shape development in various ways. Schools act as both ecological contexts characterized by peer interactions and school climate, and as institutions that have historically segregated students by race and income (Crosnoe & Johnson, 2011; Eccles & Roeser, 2011). Given the significance of school contexts to adolescent wellbeing and development, it is important to study how structural racism manifests in these contexts and its implications in the production of health inequities. We can consider how structural racism manifests in school contexts to influence health inequities in three ways: 1) in the average level of school contextual disadvantage, which is partly structured by socio-historic processes that have concentrated Black students in more disadvantaged schools, 2) through the differential distribution of resources and opportunities among Black students compared to white students within schools, and 3) through the interaction of the average level of school disadvantage and within-school racial inequities in the distribution of resources and opportunities.

First, we examine how structural racism manifests as racialized across-school differences in average levels of contextual disadvantage. Indeed, continued racial segregation has concentrated disadvantage in geographic space (Massey, 1990). For example, Black adolescents tend to be disproportionately exposed to higher levels of school social and economic contextual disadvantage than white adolescents (Boen et al., 2020). Scholars also have linked racialized contextual disadvantage to various domains, Boen et al. (2020), for example, find that schools with a greater proportion of students of color and students of lower socioeconomic status are more likely to be “toxic”, i.e., to have less perceived school safety/more perceived violence, more teacher turnover, and lower school connectedness. Students from more disadvantaged contexts and minoritized students are also more likely to miss school or be chronically absent, in substantial part due to poorer health (U.S.
Department of Education, 2018; Ready, 2010), and also to have reduced life chances (Massey et al., 1991). School socioeconomic status and student race are also associated with increased school suspensions (Anyon et al., 2014; Hemphill et al., 2014).

Building on this work, we measure manifestations of school-level contextual disadvantage in several domains, including school connectedness, disciplinary atmosphere, school attendance, and school quality (e.g., teacher turnover) characteristics. We also consider how structural racism is passed intergenerationally (e.g., through historic racialized inequities in opportunity among students’ parents), and is manifested in student background characteristics, such as parent education and parent work patterns. Finally, we measure how contextual disadvantage is manifested in not only objective measures of resources and opportunities, but in students’ perceived opportunity structures and life chances.

Second, we consider how structural racism in school contexts is manifested as the inequitable distribution of disadvantage within schools based on race. To do so, we compare the mean levels of disadvantage among Black students to the mean levels of disadvantage among white students across the same relevant domains used to measure contextual disadvantage. Third, across-school differences in contextual disadvantage and within-school racial disparities in opportunities and resources can also interact to produce frog pond effects, where racially and economically minoritized students may be at more risk of discrimination if they have more dissimilar peers, leading to disparate outcomes (Crosnoe, 2009).

2.3. Racism and depressive symptoms in adolescence

One aspect of health that is particularly consequential during adolescence is depression. Indeed, adolescent depression and depressive symptoms have increased in recent years (Keyes et al., 2019; Mojtabai et al., 2016), raising concern for negative consequences later in life. For example, adolescent depressive symptoms are associated with a higher risk of later life depressive disorders, overweight, (Aalto-Setälä et al., 2002; Liem et al., 2008), reduced educational attainment, and increased unemployment (Clayborne et al., 2019; Fletcher, 2010). The risk of developing depression dramatically increases during adolescence as compared to childhood, and the increased risk is likely partly attributable to heightened vulnerability to stress (Andersen & Teicher, 2008).

Additionally, gender differences in depressive symptoms emerge in adolescence, and adolescent girls demonstrate twice the risk of depressive symptoms as do adolescent boys (Andersen & Teicher, 2008).

Racism is a stressor known to be associated with depressive symptoms. Perceived interpersonal ethnic and racial discrimination has been associated with increased risk of depression and depressive symptoms in many studies (Brown et al., 2006; Chen & Mallory, 2021; Karlsen & Nazroo, 2002; Kessler et al., 1999; Mikut et al., 2022; Noh et al., 1999). In adolescence, perceived racial discrimination is associated with increased depressive symptoms among Black youth, with heterogeneity by gender, age, and ethnicity (Lavner et al., 2022; Seaton et al., 2010). Recent scholarship has begun to examine the association between structural discrimination and depression. It suggests that perceived systemic, or institutional, racial discrimination and residential segregation are positively associated with depression among marginalized groups (Lee, 2009; Ríos-Salas & Larson, 2015; Seaton & Yip, 2009).

Moreover, increased risk of exposure to structural adversities, such as low SES in childhood and exposure to stressful life events among racial minorities, and differential responses to structural adversities among girls compared to boys, lead to more depressive symptoms among racial minorities and girls (Adkins et al., 2009). This suggests exposure to structural racism in school might lead to race and gender heterogeneity in depressive symptoms in adolescence.

We extend this small body of work by introducing two novel school-level indices for use in the National Longitudinal Study of Adolescent to Adult Health. The first is the school contextual disadvantage index (CDI), which measures average contextual disadvantage across schools, which we argue is structured in part by racism in socio-historic processes that have concentrated Black students into more disadvantaged schools. The second is the school structural racism index (SRI), a measure of the distribution of resources and opportunities by race among students within schools. We then ask how these different school contextual indices relate to depressive symptoms. We examine these relationships for race- and gender-based adolescent subgroups as ecocultural theory posits structural racism will lead to inequities in depressive symptoms by race, while scholarship linking structural adversity to adolescent depressive symptoms suggests heterogeneity in outcomes by race and gender.

3. Methods

This study uses Wave 1 (W1) data from the National Longitudinal Survey of Adolescent to Adult Health (Add Health), a nationally representative school-based survey with measures encompassing student background characteristics, school contexts, and health outcomes. All W1 surveys in this study were fielded in 1994–1995 when students were aged 11–21. Our outcome variable, depressive symptoms, is from the W1 In-Home Survey (N = 20,745). A feature of the W1 In-Home survey is its oversample of Black students with highly educated parents, giving us additional precision in our estimates of racialized outcomes. This study focuses on self-identified non-Hispanic Black students (N = 3775) and non-Hispanic white students (N = 9589) for a total of 13,364 students with sampling data and data on depressive symptoms (students who self-identified as both Black and white, or biracial, were omitted due to small sample size). Our primary independent variables of interest, whose construction is detailed later, are the CDI and SRI, which use measures from the W1 In-School, In-Home, and School Administrator Surveys. The CDI aggregates school mean variables while the SRI aggregates school Black-white ratio variables. Missings in the CDI reduces the CDI analytic sample to N = 12,409 and missings in the SRI reduces the SRI analytic sample size to N = 8500. Missings in additional covariates (sex, age, grade, and the percentage of Black students in school) further reduces the sample sizes to a final analytic sample of 12,112 in the CDI only analyses and 8020 in SRI analyses (which also drop observations missing the CDI). The CDI and SRI analytic samples differ because the SRI only captures Black-white comparisons and 30 schools with either no Black students (N = 27) or no white students (N = 3) are dropped from this measure and SRI analyses. When limiting CDI only analyses to the SRI sample (N = 8020), results remain similar.

3.1. Dependent variable

Respondents in the Wave 1 survey were asked 19 out of 20 items from the Center for Epidemiologic Studies Depression Scale (CES-D). However, scholars have demonstrated that the 19-item CES-D is not valid for making comparisons across adolescent racial-ethnic groups in the Add Health Survey (Perreira et al., 2005), which is a key objective of this study. Therefore, we use a 5-item CES-D questionnaire, which was demonstrated to be comparable across racial groups in the Add Health cohort (Perreira et al., 2005). The 5 CES-D items included questions asking respondents “How often was the following true during the past week?: You felt you couldn’t shake the blues; You felt depressed; You felt sad; You were happy (reverse-coded); You felt life was not worth living.” Each item was asked on a 4-point scale, ranging from 0 to 3, and points were summed to a maximum total of 15. There is low missingness in each of the CES-D items (<0.5%).

3.2. Independent variables (CDI and SRI)

We operationalized the indices for across-school contextual disadvantage and within-school structural racism separately, using distinct sources of variation from variables of overlapping domains where structural racism is manifested. Table 1 describes the variables within
Table 1 Variables in the contextual disadvantage and structural racism indices.

| Domain                        | Variables                                                                 | CDI, SRI | Survey               |
|-------------------------------|---------------------------------------------------------------------------|----------|----------------------|
| **Student Body Background Characteristics** | Mother’s Education  
Father’s Education                                      |          |                     |
| **School Connectedness**      | Feel Close to People  
Feel Part of School  
Feel Happy at This School  
Feel Socially Accepted  
Feel Safe at School             |          |                     |
| **Perceived Life Chances**    | Will Live to 35  
Will Not Be Killed by 21                                 |          |                     |
|                                | Will Graduate College  
Will Have Middle Class Income                                      |          |                     |
| **Teacher-Student Racial Composition** | % Black Teachers - Student Ratio to % White Teacher -Student Ratio |          |                     |
| **School Attendance**         | Never Miss School                                                      |          |                     |
| **Disciplinary Atmosphere**   | Ever Received an Out-of-School Suspension                                |          |                     |
| **School Characteristics**    | Class Size  
Teacher Turnover                                                  |          |                     |

Each domain and whether they are used to generate the CDI, the SRI, or both. The CDI summarizes harmonized school mean values of the indicated variables as a geometric mean, capturing variation in contextual disadvantage across schools. The SRI summarizes the school Black-white ratio of the indicated variables also as a geometric mean, capturing Black-white inequities in contextual disadvantage within schools. The domains consist of 1) student body background characteristics, 2) school connectedness, 3) perceived life chances, 4) teacher-student racial composition (SRI only), 5) disciplinary atmosphere, 6) school attendance, and 7) school quality characteristics (CDI only). These domains do not capture all the innumerable ways in which structural racism may be manifesting across and within schools but take advantage of a rich body of data from the Add Health survey to make an approximation.

Within the student body background characteristics domain, measures included mother’s educational attainment and father’s educational attainment and whether students’ mothers and fathers worked for pay. The school connectedness domain contained survey questions on the frequency during the school year that students had trouble getting along with teachers or trouble getting along with students, as well as how much they agreed with the following statements: felt close to people at school, felt happy to be at this school, felt a part of this school, felt safe in their school, felt socially accepted, felt that students at this school were prejudiced, and felt teachers treated students fairly. Within the perceived life chances domain, survey questions asked whether students thought they would live to age 35, be killed by age 21, graduate from college, and have a middle-class income by age 30. Variables in the student body characteristics, school connectedness, perceived life chances, and school attendance domains were from the In-School survey of all students enrolled at each school and thus provide an indication of the overall school climate.

The teacher-student racial composition domain included a variable to assess teacher racial representation in relation to student racial representation, calculated as the relative percentage of Black teachers to the percentage of Black students divided by the relative percentage of white teachers to the percentage of white students in each school. This variable is only included in the SRI as it is exclusively a race-based comparison. This composite variable was based on self-reported race measures in the In-School Survey, which we used to calculate school mean student racial composition, as well as measures of teacher racial composition from the School Administrator Survey. The disciplinary atmosphere domain consisted of a variable that asked whether students had ever received an out-of-school suspension. The school attendance domain contained a variable measuring how often a health or emotional problem caused a student to miss school. Finally, the school characteristics domain contained measures of class size, the percentage of teachers with a Master’s degree or higher, and the proportion of teachers that have been at the school 5 or more years. School characteristics measures were not available by race, so could not be part of the SRI, but they provide important insight into institutional inequities across schools. They are therefore included only in the contextual disadvantage index. Details on the scales of each item can be found in Table S1 of the Online Supplement.

3.2.1. Contextual disadvantage index construction

The CDI was calculated based on the variables from all domains except teacher-student racial composition. To calculate the CDI, some variables were reverse coded to ensure all items were in the same direction, with higher values signifying more contextual advantage in the input variable. Then, In-School and In-Home survey variables were collapsed to generate school-level means. Details on the process of collapsing and merging are in the Online Supplement and Table S2 summarizes the input variables prior to collapsing.

To aggregate the school-level variables into a single index, we first standardized the scales of the 22 variables by creating quintile measures of each. Then, based on Equation (1), we generated the geometric mean for each school by multiplying the 22 quintile values of each variable in each school, \( x_{ni} \), and taking the \( 1/22 \)-root of the product, where \( n \) is the total number of quintile variables in the index. Thus, the geometric mean for contextual advantage ranges from 0 to 5.

\[
\left( \prod_{i=1}^{n} x_{ni} \right)^{1/n} = \sqrt[22]{x_1 x_2 \cdots x_n}
\]

We constructed the geometric mean because we do not consider the variables in our index to be fully compensatory, meaning that a surplus in the value of one variable is unlikely to fully outweigh a deficit in the value of another variable when considering their effects on adolescent health and wellbeing (OECD, 2008). For example, we consider that any reductions in depressive symptoms due to low values of student prejudice will not fully compensate for the increases in depressive symptoms due to lower average maternal education level. Geometric means are semi-compensatory and allow us to consider this theoretical distinction, whereas arithmetic means commonly used in the construction of indices do not, as they are fully compensatory.

After generating the geometric mean, we reversed it and subtracted
one to generate the CDI, which ranges from 0 to 4, with higher values representing more disadvantage. Then, we merged the CDI to the W1 In-Home Survey data, which contains our outcome variable, by school identifier. In analyses in which we examine how the CDI interacts with the SRI to influence depressive symptoms, we used a dichotomous version of the CDI variable with the CDI median as the threshold for defining low- and high-disadvantage schools.

3.2.2. Structural racism index construction

The school SRI is comprised of school Black-white ratio variables generated from the first 6 domains listed, omitting the school characteristics domain as these did not differ by race. To construct the school SRI, we first calculated the weighted school-level mean values of each variable by race in each of the Wave I In-School and In-Home surveys and then used these to generate school-level Black-white ratios for each variable. We merged the ratio variables from each survey by school identifier, normalized the ratio variables (detail in the Online Supplement), and then calculated the geometric mean as in Equation (1), but where \( x_{ni} \) denotes the ratio variables and \( n \) is the total number of ratio variables in the index. 20. Table S3 presents the ratio variables prior to aggregation in the SRI. After generating the geometric mean for each school, we reversed the scale and multiplied by 100, such that higher values of the SRI correspond with greater racial inequity, i.e., greater structural racism, on a scale from 1 to 100. Then, we additionally merged the SRI to the W1 In-Home Survey data by school identifier.

3.2.3. Missingness in the index input variables

It is important to note that missingness due to item non-response and attrition in the In-School and In-Home Surveys could create measurement error in both indices to varying degrees. Using appropriate weights in generating the school mean variables alleviate some of the bias due to attrition or survey non-response (Chen & Harris, 2020); however, item non-response remains a concern. By generating our indices based on weighted means, we in effect impute missing values as the mean value for each school or school-by-race subgroup.

3.3. Moderators

In all models, we included race (non-Hispanic Black/non-Hispanic white) and biological sex (male/female) as interaction terms. We consider biological sex to encompass both elements of biological sex and socially constructed gender. We also understand race and gender categories as socially constructed identifiers that signify larger systems of oppression that may moderate individual-level impacts of structural racism and school disadvantage. We used self-reported race from W1 In-Home Survey, based on students’ responses to “What is your race?” with the option to check all response categories that apply: “white, “black or African American”, “Native American or American Indian”, “Asian or Pacific Islander”, or “other”. We only included respondents who self-identified as white or Black or African American. We further limited the study sample to respondents who did not self-identify as Hispanic in a separate question regarding ethnicity. Our gender measure is based on the W1 In-Home survey interviewer confirmed biological sex as reported initially in the In-School survey.

3.4. Covariates

We control for student age, grade level, and the proportion of Black students in each school. Age is constructed from the W1 Survey based on reported month and year of birth in relation to the month and year of the survey. Grade level is as reported in the W1 Survey. We generated the proportion of Black students in each school by collapsing self-reported Black only race from the In-School survey data by school. Covariates are not included in initial models in each analysis but are included in subsequent models.

3.5. Statistical analysis

First, we use weighted linear regression models to measure the association between the CDI, interacted with race and gender, and depressive symptoms as in Equation (2).

\[
\text{Depressive Symptoms}_{i} = \beta_{0} + \beta_{1}X_{ni} + \beta_{2}\text{CDI}_{i} + \beta_{3}\text{CDI}_{i}X_{ni} + \ldots + \text{C}_{n} + \epsilon_{i} 
\]

where Depressive Symptoms\(_{i}\) are the total of the responses based on the 5-item CES-D scale, \(X_{ni}\) is a vector of individual race and gender, CDI\(_{i}\) is the school contextual disadvantage index, and \(C_{n}\) is a vector of controls including age, grade and the percentage of Black students in each school.

Model 1 examines the unadjusted association between the CDI and depressive symptoms fully interacted with race and gender identities, and Model 2 adds the control variables.

Next, we examine the relationship between within-school racial differences in resources and opportunities, measured with the SRI, and race and gender differences in depressive symptoms, first unadjusted and then building in control variables. We achieve this by regressing the SRI, interacted with race and gender, on depressive symptoms per Equation (3).

\[
\text{Depressive Symptoms}_{i} = \beta_{0} + \beta_{1}X_{ni} + \beta_{2}\text{SRI}_{i} + \beta_{3}\text{SRI}_{i}X_{ni} + \ldots + \beta_{4}\text{CDI}_{i} + \text{C}_{ni} + \epsilon_{i} 
\]

Model 1 measures the unadjusted association between the SRI and depressive symptoms where the SRI is fully interacted with race and gender identities, \(X_{ni}\). Model 2 builds in the control variables \(C_{ni}\), which again include age, grade, and the percentage of Black students in each school, while Model 3 additionally controls for school contextual disadvantage, CDI\(_{i}\).

Finally, we investigate how across-school contextual disadvantage (CDI) and within-school structural racism (SRI) interactively associate with depressive symptoms by race and gender. We measure the association between the dichotomized contextual disadvantage index, \(\text{dCDI}_{i}\), interacted with the SRI, race, and gender, and depressive symptoms as in Equation (4).

\[
\text{Depressive Symptoms}_{i} = \beta_{0} + \beta_{1}X_{ni} + \beta_{2}\text{SRI}_{i} + \beta_{3}\text{dCDI}_{i} + \beta_{4}\text{SRI}_{i}\text{dCDI}_{i}X_{ni} + \ldots + \text{C}_{ni} + \epsilon_{i} 
\]

Model 1 estimates an unadjusted model and Model 2 builds in controls for age, grade, and the percentage of Black students in each school, \(C_{ni}\).

4. Results

4.1. Measures of structural racism

Summary statistics for the input variables for the CDI and SRI are found in Tables S2 and S3, respectively, of the Online Appendix, along with a brief description. Descriptive statistics for the school CDI, SRI, and covariates are presented in Table 2, for the total samples and broken down by the dichotomized CDI measure, with low or high disadvantage schools being at or below and above the median CDI, respectively. Higher levels of the CDI signify more school disadvantage and higher levels of the SRI signify more within-school structural racism. Schools with higher levels of disadvantage have over double the percentage of Black students as schools with lower levels of disadvantage. Additionally, mean values of the SRI are highest in low disadvantage schools, which also have a lower percentage of Black students. Depression scale scores are higher among students in schools with high contextual disadvantage. Additional descriptive statistics by race, gender, and level of contextual disadvantage are presented in Table S4.
4.2. Relationship between the CDI and depressive symptoms

Marginal effect estimates based on the regression of depressive symptoms on the CDI are presented in Table 3. After introducing our controls, a 1-point increase in the CDI is associated with a 0.285-point (p < 0.01), 0.270-point (p < 0.01), 0.442-point (p < 0.1) and 0.204-point (p < 0.1) increase in the depressive symptoms scale among white girls, white boys, Black girls, and Black boys, respectively. Marginal differences among Black girls are markedly larger than among other groups. Fig. 1 shows the average marginal comparisons of Model 2, which include controls for age, grade, and the percentage of Black students in schools. Among Black girls, for instance, Fig. 1 demonstrates that moving from school contexts with the lowest disadvantage to the highest disadvantage is associated with an approximately 2-point increase in depressive symptoms in this group.

4.3. Relationship between the SRI and depressive symptoms

Table 4 shows the marginal effects estimates based on the regression of depressive symptoms on the school SRI. Results suggest a modest positive relationship between the SRI and depressive symptoms for Black boys and girls, a slight negative relationship for white girls, and null results for white boys, though none of the marginal comparisons reach statistical significance. For example, a 1-point increase in the SRI is associated with a 0.022-point increase in the depressive symptoms scale in Black girls. Fig. 2 presents the results of Model 3 and demonstrates, for instance, that if Black girls were to hypothetically change from a school context with no within-school structural racism, to one with the highest SRI in the sample (approximately 40), their depressive symptoms would increase by just under 1 point on average.
Table 5 Average marginal effects estimates of SRI on depressive symptoms, by race, gender, and school disadvantage.

| VARIABLES | (1) | (2) |
|-----------|-----|-----|
| White Girls, Low School Disadvantage | 0.002 | –0.003 |
| White Girls, High School Disadvantage | –0.018 | –0.020 |
| White Boys, Low School Disadvantage | 0.008 | 0.006 |
| White Boys, High School Disadvantage | –0.010 | –0.015* |
| Black Girls, Low School Disadvantage | 0.066 | 0.071** |
| Black Girls, High School Disadvantage | –0.004 | –0.006 |
| Black Boys, Low Schools Disadvantage | 0.022 | 0.042* |
| Black Boys, High School Disadvantage | –0.010 | –0.018 |
| Observations | 8020 | 8020 |
| Controls | No | Yes |

Standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

Note: Model 1 reports marginal effects estimates of the regression of depressive symptoms on the SRI, interacted with race by gender. Model 2 additionally includes controls for age, grade, and race at the time of the Wave 1 In-Home survey, and the school percentage of Black students. Regressions accounted for sampling design by including weights (gswgt1) and strata (region) and clusters (psuclid).

Source: Authors’ calculations from Add Health Data Wave 1.

5. Discussion

This study combines biosocial, life course, and stratification perspectives to develop life stage-specific indices of contextual disadvantage and structural racism in relevant social contexts. Importantly, we introduce two novel measures that capture manifestations of structural racism in school contexts, which are critical to adolescent development, and link these measures to adolescent depressive symptoms. The initial measure, the CDI, captures variation across schools in aggregate levels of resources and opportunities, which are in part attributable to the socio-historic processes of structural racism that have both concentrated Black students in schools through segregation and deprived Black Americans of resources and opportunities. The second measure, the SRI, compares the relative resources and opportunities of Black and white students within schools. Our results highlight the multifaceted nature of structural racism, demonstrating that contextual disadvantage across schools and structural racism within schools independently predict adolescent depressive symptoms, and interactively produce marked heterogeneity in depressive symptoms by race and gender.

Our findings demonstrate that Black students in our sample are more than twice as likely to attend schools with levels of contextual disadvantage above the median as compared to white students. Moreover, while increases in the CDI were associated with increased depressive symptoms among all race and gender subgroups, the increase was steepest among Black girls. Together these results suggest that at a population level, gaps in depressive symptoms between Black and white students may be explained by Black students’ disproportionate exposure to contextual disadvantage. These results add a structural racism component to other work linking elements of school contextual disadvantage, such as low levels of school connectedness, adolescent perceived life chances, school quality, and attendance, to adolescent health risk behaviors and later life health outcomes, including depression, obesity, and self-rated health (Dudovitz et al., 2016; Frisvold & Golberstein, 2013; Griffin et al., 2004; McNeely & Falci, 2004).

Additionally, we find suggestive evidence that when controlling for the CDI, exposure to within-school structural racism, as measured by the SRI, is associated with increased depressive symptoms in Black girls and boys. In other words, even when accounting for socio-historic processes of structural racism that select students into schools, differential distributions of opportunities and resources by race within schools are associated with racial differences in adolescent depressive symptoms. Given that exposure to within-school structural racism is uniquely stressful to Black students, these findings expectedly corroborate prior work linking structural racism to depressive symptoms (Lee, 2009; Ríos-Salas & Larson, 2015; Seaton & Yip, 2009). This work also aligns with studies demonstrating that within-school racial inequities, such as within-school segregation and lack of exposure to a same-race teacher, are associated with negative outcomes among Black students, such as reductions in positive behavior, educational aspirations, and academic success (Redding, 2019; Walsemann & Bell, 2010).

The significant interaction between the school-level CDI and SRI point to an apparent frog pond effect where Black students in low contextual disadvantage schools and with fewer Black students on average, but not high disadvantage schools with more Black students on average, are at increased risk of depressive symptoms as the level of within-school structural racism increases. Other studies have found similar relationships in which students with more dissimilar peers have
worse health and other outcomes. For instance, Black students in schools with a greater percentage of middle and high income peers suffer reduced psychosocial and academic outcomes compared to white students and those with lower percentages of middle and high income peers (Crosnoe, 2009). Similarly, Black adolescents that attend schools with a greater percentage of white peers report more depressive symptoms in adolescence and through early adulthood (Walsemann, Bell, & Goosby, 2011; Walsemann, Bell, & Maitra, 2011). These findings also support other recent scholarship drawing from intersectionality theory to understand health inequities. For instance, race, gender, and class identities intersect to structure school contexts in ways that shape social interactions and vary health outcomes over the life course (Polos, Koning, & McDade, 2021).

This study has several limitations. First, although our indices capture a range of domains in which structural racism is present in school contexts, structural racism is likely to characteriz an immeasurable number of domains, and thus our measures likely suffer from data availability bias (Barclay et al., 2019). If structural racism in immeasurable domains has different consequences for depressive symptoms compared to the domains we measure, our estimates of the associations among school-level contextual disadvantage, school-level structural racism, and adolescent depressive symptoms might be biased, with the direction of bias unclear. Second, although we integrate a geometric mean to address compensability among indicators, to make the indices more interpretable and accessible for future use, we chose not to employ a complicated weighting structure, such as through a confirmatory factor analysis. To address weighting concerns, we conducted a sensitivity check using factor-based indices and found qualitatively similar results.

Third, although we employ a measure of depressive symptoms that has been validated to make comparisons across racial groups, there is some evidence suggesting that Black adolescents conceptualize depression differently than other groups, leading depression to be under-identified in these groups (Lu et al., 2017). To the extent this occurs in our sample, there will be more uncertainty in effect estimates, leading to wider confidence intervals and a higher risk of type II error. Fourth, we only capture exposure to school-level structural racism in adolescence. While this is a particularly important sensitive period for human development, other sensitive periods exist earlier in the life course. Additional work aimed at more holistically measuring exposure to school structural racism at other ages is merited.

Despite these limitations, this work makes an important contribution to growing literature on structural racism by integrating measures of structural racism in school social contexts and integrating a life course perspective. Our findings demonstrate clear linkages between high levels of school contextual disadvantage and depressive symptoms, with school contextual disadvantage more likely to be experienced by Black students than white students, contributing to disparities in depressive symptoms. They also link structural racism manifested within schools to increased depressive symptoms in Black girls and boys, most notably among Black students in low disadvantage contexts. Exploration of the mechanisms generating this apparent frog pond effect is warranted. Finally, our results also have important policy implications. Given that the SRI is higher in schools below the median level of contextual disadvantage, which on average have lower percentages of Black students, efforts aimed at reducing school contextual disadvantage through economic school integration must also include mechanisms of support for racially and socioeconomically marginalized students at increased risk of depressive symptoms due to exposure to higher levels of within-school manifestations of structural racism.

Author statement

Polos conceptualized the study, developed the methodology, implemented statistical analysis, and drafted and edited the manuscript. McDade conceptualized the study, secured funding, facilitated access to the data and reviewed and edited the manuscript. Koning, Hargrove, and Kershaw reviewed and edited the manuscript.

Ethics statement

Conflicts of interest to declare: none. Research reported in this publication was supported by the Eunice Kennedy Shriver National Institute of Child Health and Human Development of the National Institutes of Health under Award Number R21HD101757. Stephanie

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**Fig. 3.** Predicted Level of Depressive Symptoms across Levels of the School SRI, by Race, Gender, and Level of School Contextual Disadvantage. Notes: Fig. 3 reflects the predicted level of depressive symptoms based on Model 2 in Table 5, which reports marginal effects from the regression of the depressive symptoms on the interaction of the SRI with the diCDI, additionally interacted with race and gender and controlling for age, grade at the time of the Wave 1 In-Home survey, and the school percentage of Black students. Source: Authors’ calculations from Add Health Data Wave 1.
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Data availability

The data that has been used is confidential.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssmph.2022.101237.

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