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## 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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### 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, the researchers 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 boys and girls within schools. Then, the researchers relate these indices to adolescent depressive symptoms. They 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. The authors 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 as the SRI 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.

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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, Cogburn and Williams 2015; Williams, Lawrence and Davis 2019). The bulk of the research linking racial discrimination and health has focused at 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 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 in order 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 in adolescence, a sensitive period of development. To do so, we develop two indices that measure two manifestations of structural racism. First, we develop a contextual disadvantage index that captures variation *across* schools in student resources and opportunities. We conceptualize this

index as capturing, in part, 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 *within* schools and captures inequities in social processes and interactions occurring in schools. Then, we investigate whether these indices predict adolescent depressive symptoms independently and interactively using Wave I survey data.

#### Background

#### 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 proxies, that produce racially disparate outcomes. Indeed, most work aimed at quantitatively measuring structural racism has bounded measures at policy-relevant 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 and Homan 2022; Lukachko, Hatzenbuehler and Keyes 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 and Dennis 2022). Still others have used residential segregation as a proxy for historically racist policies and practices (Kershaw et al. 2015; Krieger 2014). Given the focus on structures and systems as actors, this work has overlooked social contexts as places in which structural racism operates, despite the relevance of social contexts to understanding health (Visser et al. 2021).

Bonilla-Silva (1997)'s conceptualization of structural racism suggests social contexts as important places in which structural racism is reified. By his definition, the racialized structure is one in which social systems are hierarchically structured by race and differentially distribute rewards accordingly. The structure itself is comprised of the aggregate of social relations and practices based on racial distinctions (Bonilla-Silva 1997). Said differently, individuals are actors who interact in ways organized by structures to produce and reproduce structural racism and disparate outcomes. These interactions are not limited to a single system, and indeed, racialized rules are thought to organize racist everyday practices – and hence interactions – across institutions (Gee and Hicken 2021). Thus, social contexts, as primary places of social interaction, are relevant domains for measuring structural racism.

Moreover, understanding structural racism in social contexts across specific life course 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 and 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 state of development. We therefore introduce measures of structural racism that manifest within schools and examine their association with adolescent depressive symptoms.

#### Structural Racism in Adolescent School Contexts

School and family contexts are among the most important contexts to child and adolescent wellbeing, with schools becoming more influential as children develop (Parcel, Dufur and Cornell Zito 2010). Adolescents spend a considerable amount of time in schools, 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 and Johnson 2011; Eccles and Roeser 2011). Given the importance of school contexts to adolescent wellbeing and development, it is important to study racism experienced in these contexts at its implications in the production of health inequities. We can consider how structural racism operates in school contexts to influence health inequities in three ways: 1) through the socio-historic processes that have concentrated Black students in more disadvantaged schools, 2) through within-school Black-white differences in resources and opportunities, and 3) through the interaction of school disadvantage and within-school inequities.

First, because racial segregation concentrates disadvantage in geographic space (Massey 1990), Black adolescents tend to be disproportionately exposed to higher levels of school contextual disadvantage than white adolescents (Boen, Kozlowski and Tyson 2020). This form of structural racism manifests in the domains that comprise our measure of contextual disadvantage, including student background characteristics, school connectedness, student perceived life chances, disciplinary atmosphere, school attendance, and school quality (e.g., teacher turnover) characteristics. For example Boen, Kozlowski and Tyson (2020) 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., 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 (Education 2018; Ready 2010), and also to have reduced life chances (Massey, Gross and Eggers 1991). School socioeconomic status and student race are also associated with increased school suspensions (Anyon et al. 2014; Hemphill et al. 2014).

Second, school contexts may also influence racial inequities via structural racism operating *within* schools that inequitably distributes resources and opportunities to students based on race. The implications of within-school racial inequities for adolescent health are not well studied, but the little existing work in this area suggests ambiguous results. For example, racial gaps in within-school climate, i.e. safety, support, and connectedness, and in within-school segregation, i.e., racially disparate placement across curriculum levels, are associated with racial inequities in academic achievement and aspirations, respectively (Voight et al. 2015; Walsemann and Bell 2010), and academic achievement is associated with health (Lê-Scherban et al. 2014). On the other hand, within-school segregation has also been linked to reductions in risky health behaviors in Black girls (Walsemann and Bell 2010). Third, across-school differences in contextual disadvantage and within-school racial disparities in opportunities and resources are two forms of structural racism that 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).

#### 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, Olfson and Han 2016), raising greater 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, Varin and Colman 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 and 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 and Teicher 2008).

Racism is a stressor known to be associated with depressive symptoms. Perceived interpersonal ethnic and racial discrimination have been associated with increased risk of depression and depressive symptoms in numerous, but not all, studies (Brown et al. 2000; Chen and Mallory 2021; Karlsen and Nazroo 2002; Kessler, Mickelson and Williams 1999; Mikrut 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 and Larson 2015; Seaton and Yip 2009).

We extend this small body of work by introducing two novel school-level structural racism indices for use in the National Longitudinal Study of Adolescent to Adult Health. The first is the

school Contextual Disadvantage Index (CDI), which captures structural racism in socio-historic processes that have concentrated Black students into more disadvantage schools, and the second is the school Structural Racism Index (SRI), a measure contrasting Black-white disparities in resources and opportunities among students within schools. We then ask how these different aspects of structural racism in school contexts relate to depressive symptoms in raceand gender-based adolescent subgroups.

#### Methods

This study uses 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. Our index measures comprise variables from the Add Health In-School and School Administrator Surveys (Wave 1; W1). Our outcome variable, depressive symptoms, is from the W1 In-Home Survey. All W1 surveys in this study were fielded in 1994-1995 when students were aged 11-21. An added feature of the W1 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 Black and white students (however, students who self-identified as both Black and white, or biracial, were omitted due to small sample size).

We operationalized the indices for across-school contextual disadvantage and within-school structural racism, respectively, using overlapping domains. For these indices, we compiled school-level mean variables across 7 domains that contribute to school social contexts: 1)

student body background characteristics, 2) school connectedness, 3) perceived life chances, 4) teacher-student racial composition, 5) disciplinary atmosphere, 6) school attendance, and 7) school quality characteristics. The school disadvantage index is comprised of all but the teacherstudent racial composition, as this is exclusively a racial comparison measure. The school structural racism index comprised the first 6 domains listed, omitting the school characteristics domain as these did not differ by race.

Table 1 describes each variable within these domains, some of which were reverse coded to ensure all items are in the same direction, with higher values signifying more contextual advantage in the input variable. Then, after aggregating the variables, we reverse the CDI such that higher values represent more disadvantage. Within the *student body background characteristics* domain, measures included mother's educational attainment, father's educational attainment and whether students' mothers and fathers worked for pay. The *school connectedness* domain contained survey questions on the frequency per week which students had trouble getting along with teachers (reversed), trouble getting along with students (reversed), 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 (reverse), 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 (reversed to not 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 as well as teacher racial composition data 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 (reversed). The school attendance domain contained a variable measuring how often a health or emotional problem caused a student to miss school: never, just a few times, about once a week, almost every day or every day (reversed). Finally, the school characteristics domain contains 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.

#### **Dependent Variable**

Respondents in the Wave I 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 using the Add Health Data set (Perreira et al. 2005). The 5-item CES-D 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%).

#### Independent Variables

In all models, we included race (Black/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 Wave I 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 selfidentified 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 Wave 1 In-Home survey interviewer confirmed biological sex as reported initially in the In-School survey. We control for student age, grade level, and the proportion of Black students in each school. Age is constructed from the Wave I 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 Wave I 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.

Contextual Disadvantage Index and Structural Racism Index Construction Both the school CDI and SRI measures are weighted, ranked geometric means of the input variables as indicated in Table 1. We construct geometric means because we do not consider the variables in our index to be fully compensatory, i.e., 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.

To develop the school contextual disadvantage index, we first generated a weighted schoollevel mean value for each of the 23 variables indicated in Table 1. Most CDI variables came from the In-School survey and were weighted to account for the study design in generating school

means. Of the initial 82,117 observations with non-missing school weights and identifiers, individual variables were missing between 8% and 37% of responses due to a mix of item nonresponse, legitimate skip of an item, item unknown, or multiple responses. Student suspension data (N=20,698) came from the Wave I In-Home survey (N=20,745) and was weighted to account for study design in generating school means. Finally, school-level variables measuring low class size (N=164), the percentage of teachers with a Master's degree (N=162), and teacher turnover (N=157) came from the School Administrator Survey (N=172). Table S1 summarizes the input variables before they are collapsed to school-level mean variables. Data from the In-School and Wave I In-Home surveys were collapsed to generate weighted school level means, and then all three data sets were merged at the school level. After merging data from each survey, 128 schools remain in the final data set. Using the weighted school means, we created quintile measures of each variable. 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,  $x_{is}$ , and taking the 1/22-root of the product, where n is the total number of quintile variables in the index.

Eq. 1

 $\prod_{i=1}^{n} x_{is} = \sqrt[n]{x_1 x_2 \dots x_n}$ 

Models in which we interact the CDI with the SRI require a dimension reduction to be interpretable. In these models we change the CDI from a continuous variable to a dichotomous variable and we use the median as the threshold for defining low and high disadvantage schools. The SRI was developed slightly differently because each variable in the index is a Black-white ratio. To construct the school SRI, we first calculated the weighted school-level mean values of each variable by race from the Wave I In-School and In-Home surveys and then used these to generate Black-white ratios (26 schools had no Black students and thus a comparison could not be made). We normalized the ratios (detail in the Online Appendix), then calculated the geometric mean as in Equation 1, but where  $x_{is}$  denotes the ratio variables and n is the total number of ratio variables in the index, 20. Table S2 presents the ratio variables prior to aggregation in the SRI.

After constructing the SRI and the CDI, we merged these school-level measures to individual data from the Wave I In-Home survey (N=20,745). The reduction in school-level measures due to school survey-weight missingness and the inability to make Black-white comparisons in schools leads to an individual sample size reduction for the CDI to N=19,015, and for the SRI to N=14,165. Additionally, our sample is reduced by comparing only Black and white students in our analysis (N=14,735). Missingness due to item non-response and attrition in the In-School and Wave I Surveys could create measurement error in our indices to varying degrees. Using In-School and Wave I weights in generating the school mean variables alleviates some of the bias due to attrition or survey non-response (Chen 2020), however item non-response remains a concern. By generating our indices based on weighted school means, we in effect impute missing values as the mean value for each school-by-race subgroup.

**Statistical Analysis** 

After constructing the CDI and the SRI, we estimate their individual and joint associations with depressive symptoms by race and gender. We first aim to understand the unadjusted association between across-school differences in contextual disadvantage, measured with the CDI, and race and gender differences in depressive symptoms, and then the association building in controls for age, grade and the percentage of Black students in schools. To do so, 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.

Eq. 2 Depressive Symptoms<sub>is</sub> = 
$$\beta_0 + \beta_1 X_{is} + \beta_2 CDI_s + \beta_3 CDI_s X_{is} + \dots + C_{is} + \varepsilon_{is}$$

where *Depressive Symptoms*<sub>is</sub> are the total of the responses based on the 5-item CES-D scale,  $X_{is}$  is a vector of individual race and gender,  $CDI_s$  is the school contextual disadvantage index, and  $C_i$  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 and depressive symptoms per Equation 3. Eq. 3 Depressive Symptoms<sub>is</sub> =  $\beta_0 + \beta_1 X_{is} + \beta_2 SRI_s + \beta_3 SRI_s X_{is} + \dots + \beta_4 CDI_s + C_{is} + \varepsilon_{is}$ 

Model 1 measures the unadjusted association between the SRI and depressive symptoms fully interacted with race and gender identities,  $X_{is}$ , while Model 2 builds in the control variables  $C_i$ , and Model 3 additionally controls for school contextual disadvantage,  $CDI_s$ .

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,  $dCDI_s$ , interacted with the SRI, race, and gender, and depressive symptoms as in Equation 4.

Eq. 4 Depressive Symptoms<sub>is</sub> =  $\beta_0 + \beta_1 X_{is} + \beta_2 SRI_s + \beta_3 dCDI_s + \beta_3 SRI_s dCDI_s X_{is} + \dots + \beta_3 SRI_s ACDI_s X_{is} + \dots + \beta_3 SRI_s ACDI_s X_{is} + \dots + \beta_3 SRI_s ACDI_s X$ 

 $C_i + \varepsilon_{is}$ 

Again, Model 1 estimates an unadjusted model and Model 2 builds in control variables  $C_i$ .

#### Results

#### Measures of Structural Racism

Summary statistics for the input variables for the CDI and SRI are found in Tables S1 and S2, respectively, of the Online Appendix, along with a brief description. Descriptive statistics for

school CDI, SRI, and covariates, broken down by the dichotomized CDI measure, with low or high disadvantage schools being at or below and above the median CDI, respectively, are presented in Table 2. 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 approximately 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 with 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 S3 and demonstrate that depression scale scores are higher for girls than for boys, Black girls than white girls, and Black boys than white boys. Depression scale scores are highest overall for Black girls in high disadvantage contexts as compared to all other groups.

Relationship between the Contextual Disadvantage Index and Depressive Symptoms Marginal effect estimates based on the regression of depressive symptoms on the CDI are presented in Table 3. Figure 1 shows the average marginal comparisons of Model 2, which include controls for age, grade, and the percentage of Black students in schools. The CDI is associated with statistically significant increases in depressive symptoms across all groups. Marginal differences among Black girls are markedly larger than among other groups, and Figure 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. Relationship between the School Structural Racism Index and Depressive Symptoms Table 4 shows the results of the regression of depressive symptoms on the school SRI and Figure 2 presents the results of Model 3. 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. None of the marginal comparisons reach statistical significance.

# Relationship between the Interaction of the SRI and CDI and Depressive Symptoms Table 5 presents the results of the regression of depressive symptoms on the interaction of the SRI, dichotomous CDI variable, race, and gender. Figure 3 presents the associations from Model 2 of this analysis, which controls for age, grade, and the percentage of Black students in each school. Most striking are the results for Black girls and boys, where there is a large and statistically significant positive association between the SRI and depressive symptoms among those in low disadvantage contexts. For instance, in low disadvantage contexts, a 1.0 percentage-point increase in the SRI is associated with a 0.07 percentage point increase in the depressive symptom scale for Black girls (p<0.05) and a 0.04 percentage point increase for Black boys (p<0.1). Modest negative relationships between the SRI and depressive symptoms are apparent for white boys (p<0.1) and girls in high disadvantage contexts (does not reach significance). There are no clear SRI-based differences in depression for Black boys and girls in high disadvantage contexts nor white boys and girls in low disadvantage contexts.

#### Discussion

This study combines biosocial, life course, and stratification perspectives to develop life stagespecific indices of structural racism in relevant social contexts. Importantly, we introduce two novel measures 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 structural racism 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 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 student populations 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 and Golberstein 2013; Griffin et al. 2004; McNeely and Falci 2004).

Additionally, we find suggestive evidence that when controlling for the CDI, exposure to withinschool 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, racial dispersion in opportunities and resources within schools is 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 and Larson 2015; Seaton and 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 and 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 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 worse adult health than those schools with lower percentages of white peers (Goosby and Walsemann 2012). 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 and 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 characterize an immeasurable number of domains, and thus our measures likely suffer from data availability bias (Barclay, Dixon-Woods and Lyratzopoulos 2019). Assuming structural racism in immeasurable domains also has negative consequences for depressive symptoms, our results are likely to underestimate the association between school-level structural racism and adolescent depressive symptoms. 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 underidentified 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 a 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 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 higher levels of within-school structural racism.

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Variables		Index
	10	CDI, SRI
Mother's Education	Mother Works	
Father's Education	Father Works	
		CDI, SRI
Feel Close to People	Teachers are Fair	
Feel Part of School	No Trouble with Teachers	
Feel Happy at This School	No Trouble with Students	
Feel Socially Accepted	Students Not Prejudiced	
Feel Safe at School		
Ø,*		CDI, SRI
Will Live to 35	Will Graduate College	
Will Not Be Killed by 21	Will Have Middle Class Income	
<u> </u>		SRI only
% Black Teachers - Student Ratio to %		
White Teacher -Student Ratio		
		CDI, SRI
Ever Received an Out-of-School		
Suspension		
		CDI, SRI
Never Miss School		
		CDI only
Class Size		
Percentage of Teachers with a Master's		
Degree		
Teacher Turnover		
	Variables      Mother's Education      Father's Education      Feel Close to People      Feel Part of School      Feel Part of School      Feel Socially Accepted      Feel Safe at School      Will Live to 35      Will Not Be Killed by 21      % Black Teachers - Student Ratio to %      White Teacher -Student Ratio      Ever Received an Out-of-School      Suspension      Never Miss School      Class Size      Percentage of Teachers with a Master's      Degree      Teacher Turnover	Variables      Variables      Mother's Education    Mother Works      Father's Education    Father Works      Feel Close to People    Teachers are Fair      Feel Part of School    No Trouble with Teachers      Feel Socially Accepted    Students Not Prejudiced      Feel Safe at School    Will Graduate College      Will Live to 35    Will Graduate College      Will Not Be Killed by 21    Will Have Middle Class Income      % Black Teachers - Student Ratio to %    Will Have Middle Class Income      % Black Teacher - Student Ratio    Ever Received an Out-of-School      Suspension    Class Size      Percentage of Teachers with a Master's    Degree      Teacher Turnover    Ever Turnover

Table 1. Variables in the Contextual Disadvantage and Structural Racism Indices

#### Table 2. Descriptive Statistics by Level of School Disadvantage

	Low Schoo	l Contextu	al	High School Contextual					
	Disadvanta	ige		Disadvantage					
	Mean	SE	N	Mean	SE	N			
School Contextual									
Disadvantage Index	1.914	0.078	9029	3.034	0.048	8710			
School Structural Racism Index	0.150	0.014	9029	0.125	0.011	8710			
CES-D 5 Item Depression Scale	2.344	0.053	9029	2.891	0.065	8710			
Age	15.373	0.198	9026	15.920	0.221	8709			
Grade Wave 1	9.345	0.195	8897	9.779	0.222	8504			
School-level Percent Black	0.107	0.020	9029	0.230	0.033	8710			

Notes: Initial summary statistics for Wave 1 predictors and controls, by level of school contextual disadvantage, where low disadvantage schools are those at or below the median and high disadvantage schools are those above the median. The CDI ranges from 0 to 4, with higher values representing more contextual disadvantage. The SRI ranges from 0 to 1, which higher values representing more within-school structural racism.

	by Race and Gender		
	(1)	(2)	
VARIABLES			
White Girls	0.404***	0.285***	
	(0.097)	(0.098)	
White Boys	0.374***	0.270***	
	(0.062)	(0.052)	
Black Girls	0.534**	0.442*	. 0,
	(0.225)	(0.225)	
Black Boys	0.246**	0.204*	
	(0.117)	(0.115)	
Observations	12,440	12,138	
Controls	No	Yes	

Table 3. Average Marginal Effects Estimates of CDI on Depressive Symptoms,

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

Notes: Model 1 reports marginal effects estimates of the regression of the CDI on depressive symptoms by race and gender. Model 2 additionally includes controls for age, grade 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 (psuscid).

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	Genuer		
	(1)	(2)	(3)
/ARIABLES			
White Girls	-0.010	-0.008	-0.006
	(0.009)	(0.008)	(0.009)
White Boys	-0.001	-0.002	0.000
	(0.007)	(0.006)	(0.005)
Black Girls	0.009	0.020	0.022
	(0.024)	(0.023)	(0.019)
Black Boys	0.012	0.012	0.017
	(0.012)	(0.015)	(0.015)
Observations	8,527	8,292	8,041
Controls	No	Yes	
Controls + CDI		sV	Yes

Table 4. Average Marginal Effects Estimates of SRI on Depressive Symptoms, by Race and Gender

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

Notes: Model 1 reports marginal effects estimates of the regression of the SRI on depressive symptoms by race and gender. Model 2 additionally includes controls for age, grade at the time of the Wave 1 In-Home survey, and the school percentage of Black students. Model 3 additionally includes the controls from Model 2 as well as a control for the school CDI. Regressions accounted for sampling design by including weights (gswgt1) and strata (region) and clusters (psuscid).

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	(1)	(2)
VARIABLES		
White Girls, Low School Disadvantage	0.000	-0.001
	(0.010)	(0.009)
White Girls, High School Disadvantage	-0.021	-0.020
	(0.017)	(0.016)
White Boys, Low School Disadvantage	0.009	0.006
	(0.008)	(0.007)
White Boys, High School Disadvantage	-0.009	-0.015*
	(0.010)	(0.008)
Black Girls, Low School Disadvantage	0.052	0.071**
	(0.040)	(0.033)
Black Girls, High School Disadvantage	-0.012	-0.006
	(0.017)	(0.018)
Black Boys, Low Schools Disadvantage	0.023	0.042*
	(0.021)	(0.023)
Black Boys, High School Disadvantage	0.008	0.001
	(0.014)	(0.017)
Observations	8,272	8,041
Controls	No	Yes

Table 5. Average Marginal Effects Estimates of SRI on Depressive Symptoms, by Race, Gender, and School Disadvantage

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

Notes: Model 1 reports marginal effects estimates of the regression of the SRI interacted with the CDI on depressive symptoms by race and gender. Model 2 additionally includes controls for age, grade 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 (psuscid).





Figure 1. Predicted Probability of Depressive Symptoms across Levels of the School CDI, by Race and Gender. Notes: Figure 1 reflects the predicted probability of depressive symptoms based on Model 2 in Table 3, which reports marginal effects from the regression of the CDI on depressive symptoms, 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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Figure 2. Predicted Probability of Depressive Symptoms across Levels of the School SRI, by Race and Gender. Notes: Figure 2 reflects the predicted probability of depressive symptoms based on Model 3 in Table 4, which reports marginal effects from the regression of the SRI on depressive symptoms, interacted with race and gender and controlling for age, grade at the time of the Wave 1 In-Home survey, the school percentage of Black students, and the CDI. Source: Authors' calculations from Add Health Data Wave 1.

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Figure 3. Predicted Probability of Depressive Symptoms across Levels of the School SRI, by Race, Gender, and Level of School Contextual Disadvantage. Notes: Figure 3 reflects the predicted probability of depressive symptoms based on Model 2 in Table 5, which reports marginal effects from the regression of the interaction of the SRI with the dCDI on depressive symptoms, 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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#### **Online Supplement**

	Obs	Mean	SD	Min.	Max.
Mother's Education	64019	2.777	1.189	1	5
Father's Education	51859	2.93	1.267	1	5
Mother Works	69254	0.818	0.386	0	1
Father Works	58385	0.958	0.201	0	1
Will Live to 35	75906	7.634	1.979	1	9
Will Not Be Killed by 21	74750	7.577	1.677	1	9
Will Graduate College	67935	7.346	2.293	1	9
Will Have Middle Class Income	74199	6.122	2.329	1	9
Feel Close to People	73394	3.54	1.102	1	5
Feel Part of School	72803	3.522	1.191	1	5
Students Not Prejudiced	71566	2.761	1.132	1	5
Feel Happy at This School	72401	3.543	1.219	1	5
Teachers are Fair	72236	3.396	1.116	1	5
Feel Socially Accepted	71764	3.759	0.98	1	5
Feel Safe at School	72113	3.676	1.076	1	5
Never Miss School	74936	4.471	0.678	1	5
No Trouble with Teachers	77230	3.792	1.292	1	5
No Trouble with Students	77023	3.463	1.465	1	5
Never Suspended	20698	0.712	0.453	0	1
Low Class Size	164	25.329	5.512	10	39
% Teachers with M.A.	162	50.444	25.764	0	100
Teacher Turnover	157	67.911	20.842	1	100

#### Table S1. Measures in the CDI before Collapsing

Notes: Summary statistics for Wave 1 variables comprising the CDI. Higher values represent more advantage and are rescaled after aggregating such that the higher values of the CDI represent more disadvantage. Source: Authors' calculations from Add Health Data Wave 1 In-School, In-Home, and Administrator Surveys.

	Obs	Mean	SD	Min	Max	
Mother's Education Patio	07	0.02	0 105	0.307	1 <sup>1107.</sup>	
	97	0.95	0.105	0.397	1	
Father's Education Ratio	95	0.92	0.112	0.462	1	
Mother Works Ratio	99	0.965	0.146	0.01	1	
Father Works Ratio	97	0.95	0.139	0.01	1	
Will Live to 35 Ratio	101	0.934	0.088	0.508	1	
Will Not Be Killed by 21 Ratio	101	0.966	0.067	0.622	1	$\cap$
Will Graduate College Ratio	101	0.96	0.102	0.153	1	0
Will Have Middle Class Income Ratio	101	0.918	0.12	0.387	1	
Feel Close to People Ratio	101	0.93	0.09	0.556	1	$\sim$
Feel Part of School Ratio	101	0.931	0.111	0.436		
Students Not Prejudiced Ratio	101	0.957	0.106	0.33	1	
Feel Happy at This School Ratio	101	0.908	0.116	0.426	1	
Teachers are Fair Ratio	101	0.954	0.058	0.729	1	
Feel Socially Accepted Ratio	101	0.979	0.068	0.509	1	
Feel Safe at School Ratio	101	0.974	0.05	0.737	1	
Never Miss School Ratio	101	0.97	0.061	0.642	1	
No Trouble with Teachers Ratio	102	0.891	0.169	0.246	1	
No Trouble with Students Ratio	102	0.861	0.165	0.264	1	
Never Suspended Ratio	91	0.772	0.258	0.01	1	
Ratio of Same Race Teachers to Students	102	0.393	0.39	0.01	1	
Never Miss School Ratio	101	0.97	0.061	0.642	1	

Table S2. Ratio Measures in the Structural Racism Index

Notes: Summary statistics for Wave 1 constructed ratio variables comprising the SRI. Values of 1 represent racial parity, so higher values represent less racism in the input variables. However, after aggregating the ratios, the scale is reversed such that higher values represent more racism.

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#### Interpretation of Summary Statistics of Input Variables

Higher values of the input variables of the CDI represent more advantage in these initial summary statistics. For the SRI, ratio measures of 1 suggest racial parity and lower values indicate more disadvantage experienced by Black participants in comparison with white participants for each variable. The means of most variables are close to one, signaling that mean within-school racial inequities based on these measures is modest. However, the standard deviations, minimums, and maximums of the ratio measures reveal important variation in the SRI between schools, which we use in our regression analysis. After aggregating these variables, the indices are reversed such that higher levels of the CDI signify more school disadvantage and higher levels of the SRI signify more within-school structural racism.

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#### **Construction and Normalization of Ratio Variables for the SRI**

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To construct the ratios, we first constructed Black race in the same manner as we constructed the covariate variable, but using data from the In-School Survey, which has a larger school sample size and is more appropriate for the generation of school means. (We use race from the Wave I survey in the final analysis because many respondents were absent from the In-School Survey but present in the Wave I In-Home Survey). Given that dividing proportions can produce values that are not on the same scale, we normalized the ratios using min-max methods. While typically a minimum would be set at 0, because calculating the geometric mean requires multiplying values, we substituted 0.01 for 0 to alleviate the problem whereby the product of 0 and any other numbers is 0. We also set the maximum to 1, substituting 1 for any value over 1. This maximum is theoretically aligned with our definition of structural racism because values over 1 suggest that Black students are more advantaged than white students, and thus do not capture structural racism.

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	_					Girls				A		
			White						Black			
	Low School Disadv.			High School Disadv.			Low School Disadv.			High School Disadv.		sadv.
	Mean	SD	Ν	Mean	SD	Ν	Mean	SD	Ν	Mean	SD	Ν
School CDI	1.876	0.069	2875	2.936	0.072	1568	1.986	0.096	766	3.004	0.057	1150
School SRI	0.151	0.017	1790	0.121	0.014	860	0.125	0.016	657	0.117	0.013	970
CES-D Depression Scale	2.451	0.073	2867	3.007	0.094	1567	2.909	0.253	766	3.359	0.131	1144
Age	15.112	0.179	2875	15.804	0.199	1568	15.314	0.316	766	15.804	0.284	1150
Grade Wave 1	9.212	0.180	2822	9.811	0.216	1517	9.329	0.331	747	9.680	0.286	1113
School-level Percent Black	0.047	0.008	2875	0.108	0.027	1568	0.386	0.082	766	0.440	0.055	1150

#### Table S3. Summary Statistics by Race, Gender, and Level of School Disadvantage

						Boys						-
			White		0,				Black			
	Low So	chool Di	sadv.	High So	chool Di	sadv.	Low Sc	hool Dis	adv.	High So	chool Di	sadv.
	Mean	SD	Ν	Mean	SD	Ν	Mean	SD	Ν	Mean	SD	Ν
School CDI	1.848	0.072	2767	2.940	0.066	1588	2.013	0.071	672	3.042	0.066	1054
School SRI	0.155	0.015	1734	0.117	0.014	834	0.131	0.013	560	0.115	0.015	867
CES-D Depression Scale	1.838	0.061	2760	2.364	0.059	1587	2.284	0.100	668	2.574	0.082	1050
Age	15.271	0.173	2766	16.066	0.212	1588	15.703	0.359	670	15.879	0.332	1054
Grade Wave 1	9.230	0.175	2728	9.884	0.222	1540	9.314	0.342	649	9.537	0.317	1025
School-level Percent Black	0.047	0.008	2767	0.111	0.026	1588	0.386	0.090	672	0.452	0.052	1054

Notes: Summary statistics for Wave 1 predictors and controls, by race, gender, and level of school contextual disadvantage, where low disadvantage schools are those at or below the median and high disadvantage schools are those above the median. The CDI ranges from 0 to 4, with higher values representing more contextual disadvantage. The SRI ranges from 0 to 1, which higher values representing more within-school structural racism. Source: Authors' calculations from Add Health Data Wave 1 In-School, In-Home, and Administrator Surveys.

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