

Long-Term Exposure to Neighborhood Policing and the Racial/Ethnic Gap in High School Graduation¹

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Abstract

Researchers increasingly explore the consequences of policing for the educational outcomes of minority youth. This study contributes to this literature by asking: First, what are racial/ethnic disparities in long-term exposure to neighborhood policing? Second, how does this exposure affect high school graduation? Third, how much of the ethnoracial gap in high school graduation would remain if neighborhood policing was equalized? To address these questions, we use data from the New York City Department of Education and follow five cohorts of NYC public school students from middle to high school. Our findings reveal starkly different experiences with neighborhood policing across racial/ethnic groups. Using novel methods for time-varying treatment effects, we find that long-term exposure to neighborhood policing has negative effects on high school graduation with important differences across racial/ethnic groups. Using gap-closing estimands, we show that assigning a sample of Black and Latino students to the same level of neighborhood policing as white students would close the Black-white gap in high school graduation by more than one quarter and the Latino-white gap by almost one fifth. Alternatively, we explore interventions where policing is solely a function of violent crime, which close the Black-white gap by as much as one-tenth. Our study advances previous research by focusing on cumulative, long-term exposure to neighborhood policing and by assessing various counterfactual scenarios that inform research and policy.

Keywords: Policing, Education, Inequality, Neighborhoods, Racial Disparities

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Introduction

Neighborhood policing is an important aspect of urban life that is central to debates about racial inequities. Previous research shows that exposure to neighborhood policing has a negative impact on academic performance and other outcomes (Ang 2021; Gottlieb and Wilson 2019; Hirschfield 2009; Hjalmarsson 2008; Kirk and Sampson 2013; Legewie and Fagan 2019; Shedd 2015). This research focuses on single incidents of police stops, arrests or acts of police violence, or short-term exposure to neighborhood policing. Exposure to policing, however, cumulates over extended periods of time, such that systematic ethnic and racial differences in exposure can grow over adolescence, resulting in cumulative disadvantages for minority youth (Justice 2021). Building on prior research on the temporal dimensions of neighborhood effects (Wodtke, Harding, and Elwert 2011), our study contributes to this growing literature by focusing on ethnic and racial disparities in long-term exposure to neighborhood policing.

Using administrative data from the New York City Department of Education and the New York City Police Department, we follow five cohorts of 231,177 NYC public school students over an eight-year period from middle to high school. First, we document racial and ethnic disparities in long-term exposure to neighborhood policing over key developmental periods. Second, we focus on the effect of long-term exposure to policing on high school graduation. Using innovative methods for time-varying treatment effects (Wodtke et al. 2011; Zhou and Wodtke 2020) allows us to examine the role of cumulative exposure across middle and high school. These models address the dynamic relation between neighborhood crime and policing, in which the level of policing in one period is affected by crime in previous periods. Third, we assess several counterfactual scenarios that help us understand how the racial/ethnic gap in high school graduation would change for a sample of students if exposure to neighborhood policing were equalized or solely based on neighborhood crime using novel gap-closing estimands (Lundberg 2021).

Descriptively, we show that differential neighborhood policing cumulates to create striking ethnic and racial disparities in exposure to the criminal justice system over adolescence. Though levels of neighborhood policing decline over the observation period, ethnic and racial disparities in cumulative exposure persist across cohorts. We also show that the cumulative nature of exposure matters: compared to our measure of cumulative exposure, focusing on middle or high

school exposure alone understates the negative impact of neighborhood policing on minority students' high school graduation rates. Counterfactual scenarios illustrate that assigning a sample of Black and Latino students to the same level of neighborhood policing as white students would reduce the Black-white gap in high school graduation by 27.8% and the Latino-white gap by 17.5%. However, assigning neighborhood policing solely as a function of violent crime reduces the Black-white gap to a more modest extent by 10.3%.

Our results highlight policing as one of many mechanisms through which neighborhoods shape children's life chances (Harding et al. 2010; Chetty et al. 2014; Sampson 2012) and create starkly different residential experiences for Black and white youth (Peterson and Krivo 2010; Massey and Denton 1993). By showing how long-term exposure to neighborhood policing matters for high school graduation above and beyond crime and other common neighborhood characteristics (Sharkey and Torratts-Espinosa 2017; Torratts-Espinosa 2020), these findings also heed the call to examine how policing shapes social structure above and beyond its effects on crime (Bell 2021).

Neighborhood Policing and Educational Outcomes

A growing effort among social scientists examines how ethnic and racial inequalities in direct and indirect contact with the criminal justice system shape educational outcomes. Researchers focusing on direct criminal justice system exposure suggest that students who experience arrests (Sweeten 2006; Hirschfield 2009; Lopes et al. 2012; Kirk and Sampson 2013) and juvenile incarceration (Aizer and Doyle 2015) are more likely to drop out of high school and less likely to enroll in higher education (Kirk and Sampson 2013; Widdowson, Siennick, and Hay 2016). Other research documents the deleterious effects of indirect exposure to the criminal justice system on educational outcomes via parental incarceration (for a review, see Foster and Hagan 2009; 2015), vicarious exposure through friends or family members (Gottlieb and Wilson 2019), or exposure to neighborhood and school-level policing (Bacher-Hicks and Campa 2020; Legewie and Fagan 2019; Ang 2021; Browning et al. 2021). This work consistently documents the negative effects of various types of direct and indirect criminal justice contact on educational outcomes like test scores or high school graduation.

Most important for this study, several articles focus on neighborhood or school-level exposure to policing. Legewie and Fagan (2019), for example, show that neighborhood-level exposure to aggressive policing programs has substantial negative impacts on minority children's test scores, with larger effects for Black compared to Latino students. Ang (2021) focuses on incidents of police violence in the residential environment and similarly finds negative effects on minority students' GPA with no effects on white students. Closely related research focuses on school-level exposure to police stops and documents comparable negative effects on Black students' high school graduation rates, with potential positive effects for white students (Bacher-Hicks and Campa 2020). This work consistently finds larger effects on Black students as the racial group disproportionately targeted by policing.

Two key mechanisms explain the effect of neighborhood-level proactive policing on educational outcomes. The first focuses on eroded trust in state institutions and system avoidance. Negative encounters with the police, such as mistreatment, procedural injustice among friends and family members, or neighborhood-level exposure to aggressive policing programs can negatively impact perceptions of police legitimacy, reduce trust in government, and lead to withdrawal from state institutions, including schools (Geller and Fagan 2019; Bell 2020). Other research focuses on broader systems of surveillance across state institutions, describing system avoidance as a behavioral response in which individuals avoid institutions that are involved in surveillance and keep formal records (Brayne 2014:368). Both distrust in law enforcement and avoidance of state institutions have implications for educational outcomes like high school graduation. Indeed, empirical research directly ties system avoidance following paternal incarceration to reductions in parental involvement in schooling (Haskins and Jacobsen 2017) and a recent national analysis from the Urban Institute finds that more than 65% of high school students attend schools with law enforcement presence (Lindsay, Lee, and Lloyd 2018). Exposure to police officers at school together with zero-tolerance discipline policies highlight how distrust of the legal system may impact school attendance and educational outcomes more broadly.

A growing literature documents a second mechanism, which focuses on the negative health effects of police contact that can impact children's educational performance. Geller et al. (2014), for example, show that participants who report prior encounters with the police display higher rates of trauma and anxiety, particularly when stops were intrusive or perceived as unfair.

Building on the stress process paradigm, Sugie and Turney (2017) look at a set of criminal justice contacts including arrest, conviction, and incarceration and find negative consequences for mental health. Sewell and colleagues focus on neighborhood-level exposure to policing and show similar negative effects on stress, trauma, anxiety and other mental health problems (Sewell et al. 2020; Sewell, Jefferson, and Lee 2016; Sewell and Jefferson 2016). Toro and collaborators (2019) link these health effects to educational outcomes. They show that part of the relationship between direct and vicarious police contact and grades in school is mediated by psychological distress, sleep problems, and self-rated health. Both processes explain the potential effect of neighborhood-level proactive policing on educational outcomes.

Cumulative Exposure to Neighborhood Policing and The Racial/Ethnic Gap in High School Graduation

While previous research documents the social consequences and costs of proactive policing programs for the education of minority youth, this work focuses either on single incidents of police stops, arrests or acts of police violence, or short-term exposure to neighborhood policing. Legewie and Fagan (2019) examine the effect of immediate exposure to an aggressive policing program over a single year on test scores, and Ang (2021) focuses on the acute effect of police killings in the residential environment on GPA. This approach ignores the potential for cumulative effects of exposure to policing over extended periods of time experienced by many minority youth. In this article, we follow five cohorts of middle school students in New York City over eight years and focus on long-term exposure to policing throughout adolescence. This longitudinal perspective advances the literature in three important ways.

First, research focused on the acute or “short run” effects of neighborhood policing potentially underestimates the effect of cumulative exposure. Many of the mechanisms at the core of policing effects and the effects of racism on individual outcomes focus on long-term and repeated exposure. System avoidance and legal estrangement, for example, are cumulative processes of disengagement from formal institutions that develop in response to sustained and repeated experiences of injustice over an extended period of time (Bell 2017). Incidents of police violence, racial discrimination, or other encounters that initially act as acute stressors translate to chronic stressors with additional health consequences as a result of sustained and repeated exposure to policing and structural racism. Accordingly, the focus on long-term exposure to

neighborhood policing documents the cumulative effect that is essential for understanding the consequences of neighborhood policing for child development.

Second, a longitudinal perspective allows us to better measure racial and ethnic disparities in exposure to neighborhood policing. Policing in New York City and many metropolitan areas underwent major changes over recent decades. After a steep increase in the use of the Stop, Question and Frisk (SQF) operations during the 2000s, the use of police stops peaked in 2011 with over 650,000 incidents. In response to the public outcry against the Stop, Question and Frisk (SQF) program and the *Floyd v City of New York* lawsuit, the NYPD dramatically reduced the number of stop and frisk operations over the following years, reaching about 45,000 in 2014. As a result, early cohorts in our sample were exposed to an average of 2,210 police stops in their residential census tract compared to an average of just 1,157 stops for later cohorts. At the same time, families move between neighborhoods, with implications for their local exposure to neighborhood policing (de Souza Briggs and Keys 2009; Wodtke et al. 2011). In light of these shifts, a longitudinal perspective more accurately reflects the experiences of adolescents in their neighborhoods.

Third, a longitudinal perspective allows us to disentangle the dynamic relationship between neighborhood policing and neighborhood crime. Neighborhood crime is associated with both neighborhood policing and children's educational attainment (for a review, see Sharkey 2018), and behavioral adaptations to crime develop over extended periods (Harding 2009). Policing can thus have positive consequences for youths' educational outcomes by reducing students' exposure to violent crime over time. Research suggests that declines in violent crime attributable to exogenous increases in the availability of funds to hire police officers via federal funds substantially raised ELA test scores, particularly among Black youth (Torrats-Espinosa 2020). Examining the effect of recent exposure to police stops while adjusting for violent crime might thus control away the positive impact of prior levels of policing on declines in subsequent crime levels. Our longitudinal perspective uses novel methods to adjust for time-varying confounders, allowing us to examine the effect of policing on children's high school graduation while considering the dynamic relationship between neighborhood policing and crime.

Together, these advances allow us to more precisely measure and assess the consequences of exposure to neighborhood policing, with implications for our understanding of its effects on child development, urban inequality, and the racial/ethnic gap in high school graduation. To

leverage these insights, we further study several counterfactual scenarios that help us assess how the racial/ethnic gap in high school graduation would change depending on different levels of exposure to neighborhood policing.

Data and Methods

Our analyses follow five cohorts of middle school students over 8 years using administrative school district records from the New York City Department of Education (NYCDOE). The school district records consist of student-level data from all NYC public-school students in grades 6 to 12 from the school years 2006 to 2018. We focus our analysis on the 2005-2006 to 2009-2010 (five) cohorts of middle school students. Each cohort is defined as all students who enrolled in 6th grade for the first time in a respective school year. We track these cohorts for 8 years to capture their long-term exposure to neighborhood policing during an important developmental period prior to our key outcome variable, high school graduation.

We link student data to information on pedestrian stops from the Stop, Question and Frisk (SQF) program, and crime complaints from the New York Police Department based on residential census tracts. The SQF program regulates police stops in situations where officers reasonably suspect that a person has committed, is committing, or is about to commit a felony or a Penal Law misdemeanor (Ridgeway 2007). Stops are well documented and reliably recorded on the “Stop, Question and Frisk Report Worksheet” (UF-250 form) during the height of the SQF program but possibility under-reported in later years (Ridgeway 2007; Eterno and Silverman 2012; Braga, MacDonald, McCabe 2021). The possible underreporting of stops in later years is an important data limitation discussed below. NYPD crime complaints include geocoded, incident-level felony, misdemeanor, and violation crimes reported to the NYPD. Official crime data is limited to incidents known to the police either through citizen or police reporting. This data limitation, however, is less problematic when studying police behavior because police cannot respond to crime unknown to them. While unreported crime likely impacts educational outcomes as well, it is presumably not related to neighborhood police stops or arrests and therefore not a major concern for our analysis.

Outcome

Our *main dependent variable* is high school graduation. High school graduation is a hugely important milestone in the educational trajectory of adolescents with implications for a range of social, economic and health outcomes later in life (Rumberger 1987; Rumberger and Rotermund 2012). We measure whether students graduate within eight years from their initial enrollment in 6th grade, allowing for one additional year compared to on-time graduation. We exclude students who leave NYC public schools (see details below) so that our analyses compare graduating students to students who drop out or are still actively enrolled at the end of our observational period.

Treatment and Covariates

Our *main independent variable* measures cumulative, neighborhood-level exposure to police stops in the 6 years after students enroll in 6th grade. Stop, Question and Frisk (SQF) operations in New York City were a core component of proactive policing programs that use police stops to engage citizens, targeting low-level crimes and minor disorderly behavior (Zimring 2013). SQF operations are particularly salient for middle and high school students because they frequently target young people of color (Figures and Legewie 2019; Geller 2021). In supplementary analysis, we present results for the cumulative number of low-level arrests, defined as all misdemeanor and violation arrests in students' residential census tract. While arrests are still uncommon for students in our sample, they are an alternative measure of proactive policing that allows us to assess the robustness of our findings.

We define $A_t \in \{0,1,2,\dots,5\}$ as the number of police stops in a student's residential census tract during the fall term of calendar year. To measure cumulative exposure to police stops, we sum over year 1 to 5 $cum(A) = \sum_{k=1}^5 A_k$ and divide this student-level measure into quintiles defined over all students in the sample.² The result is a categorical measure of cumulative exposure to neighborhood policing in the residential environment during middle and high school ranging from very low to very high. "Very low" indicates that a student experienced between 0 and 201 police stops during year 1 to 5 (1st quintile), "low" indicates 202 to 393 police stops (2nd

² Less than 1% of the sample (2,941 students or 0.869%) drop out of school before the end of the period during which we measure cumulative exposure to police stops. In supplementary analysis, we exclude these students from the analytic sample. The results are substantively the same as the findings presented below.

quintile), “average” 394 to 680 (3rd quintile), “high” 681 to 1,208 (4th quintile), and “very high” 1,209 to 10,866 (5th quintile). Compared to a continuous measure, this categorical variable provides two key advantages³: First, it allows us to measure non-linear effects of cumulative exposure to neighborhood policing. Second, it makes it possible to identify gap-closing estimands and therefore directly link the two parts of our analysis.

In additional analysis, we measure exposure to police stops during a single year either in middle or high school. These measures are similarly divided into quintiles for “middle school exposure” ($t=1$) and “high school exposure” ($t=3$). They allow us to compare the effect of cumulative exposure with short-term exposure over a single year as more commonly used in previous research.

In addition, we use three measures of crime as time-varying, neighborhood-level covariates $L_t^x \in \{0,1,2,\dots,5\}$: the number of violent crimes, the number of property crimes and the number of misdemeanors in the spring term. To ensure a clear temporal order between treatment and confounders across our analyses, these time-varying confounders are measured during the spring term, while the treatment variable is measured during the fall term of the same calendar year. Table A1 illustrates this temporal structure for the 2005-2006 middle school cohort.

Finally, our analyses include *baseline covariates* on the student and neighborhood level. On the student-level, we control for cohort, gender, free lunch status as a measure of parental socioeconomic background, English learner status as a measure of immigrant background, and 6th grade English Language Arts (ELA) and Mathematics test scores. Both free lunch status and English learner status are binary variables that indicate whether a student ever received free lunch or was designated as an English learner by the NYCDOE. Adjusting for cohort ensures that we control for all time-specific characteristics that are common across students from the same cohort such as general economic conditions or changes in the reporting practices of police stops (including possible under-reporting). On the neighborhood-level, we control for several characteristics of student’s baseline neighborhood (residential census tract in 6th grade) derived from the 2010 decennial census and the 2006–10 American Community Survey five-year estimates. These variables include police precinct fixed effects, population size, racial

³ Table A2 reports the regression results for a continuous (logged) measure of cumulative exposure. Converting continuous treatment variables into categorical variables can be problematic if the distribution of students within quintiles differs across groups. The results in Table A2 alleviate these concerns. They show a similar pattern although the results provide clearer evidence for a potential negative effect on white students.

composition in terms of proportion Black, Asian, Latino and other residents with proportion white as a reference, residential instability and concentrated disadvantage. Residential instability and concentrated disadvantage are indices constructed from an exploratory maximum likelihood factor analysis with one factor solutions. The factor analysis for concentrated disadvantage includes poverty rate, unemployment rate, professional jobs, share of high school graduates, share of single-mother families; and residential instability includes percentage of renter-occupied units, share of residents who moved between 2000 and 2009, and housing unit rental vacancy rate. Finally, we control for cumulative exposure to police stops around school defined as the number of police stops within 500 meters of a school. This control variable ensures that our results for neighborhood-level exposure to policing are not driven by exposure to policing at school.

Table 1 provides summary statistics for all the variables by race/ethnicity.

[Table 1 about here]

Estimation Strategy

Estimating the effect of cumulative exposure to neighborhood police stops on high school graduation is challenging because policing is a time-varying treatment that is closely linked to crime. The level of neighborhood crime at a particular point in time is affected by recent policing, which itself is influenced by previous criminal activity. This dynamic relationship raises concerns about post-treatment confounding (Zhou and Wodtke 2020). The naïve approach to condition on post-treatment confounders is problematic because it may induce bias by blocking causal pathways, controlling away the effect of the treatment on the outcome that operates through the time-varying confounder, or by leading to spurious associations between treatment and outcome via collider stratification bias if these confounders share unobserved common causes with the treatment.

One approach to overcome this challenge are marginal structural models (MSMs) with residual balancing to construct weights designed to account for dynamic causal relationships between time-varying treatments and confounders (Zhou and Wodtke 2020; Imai and Kim 2019; Wodtke et al. 2011). Residual balancing requires modeling the conditional means of the post-

treatment confounders $\mathbf{X}_j$ to obtain a set of weights that balance the residuals from these models across future levels of treatment $\mathbf{A}$ and prior levels of the treatment and the confounders. Estimating marginal structural models using these weights creates a pseudo-population where time-varying, post-treatment confounders ($\mathbf{X}_{it}$) do not predict future treatments, conditional on prior values of the treatment ($\mathbf{A}_{it}$) and prior values of the confounder ($\mathbf{X}_{it-1}$). In this pseudo-population, the residualized post-treatment confounders $\mathbf{X}'_{it}$ are balanced across levels of the treatment $\mathbf{A}_{it}$ while remaining uncorrelated to the observed past ($\mathbf{A}_{it-1}$ and $\mathbf{X}_{it-1}$). This procedure properly adjusts for biases arising from post-treatment confounding without overcontrolling for the effect of the treatment or inducing collider stratification bias. For details on the implementation and construction of weights, see Zhou and Wodtke (2020).

In the context of this study, we implement residual balancing to purge the effects of crime on policing from post-treatment confounding. We model all time-varying control variables as a function of lagged measures of time-varying control ($\mathbf{X}_{jt-1}$) and treatment variables ($\mathbf{A}_{jt-1}$). These time-varying variables j include counts of violent, property, and misdemeanor crimes during the spring term, modelled as a function of the treatment during the previous fall and violent, property, and misdemeanor crimes during the preceding spring⁴. We then implement the residual balancing procedure with the R package “rbw” (Zhou and Wodtke 2020). Using the re-weighted sample, we estimate the following MSM:

$$Y_{ij} = \alpha + \sum_{k=1}^4 \delta_k A_{ik}^{\text{quintile}} + \beta_1 \mathbf{X}_i + \beta_2 \mathbf{U}_{ij} + \varepsilon_{ij}$$

where $\sum_{k=1}^4 \delta_k A_{ik}^{\text{quintile}}$ refers to four indicator variables for low, average, high and very high level of neighborhood policing in student i 's residential neighborhood from year 2 to 6 in our sample ($t = 1$ to $t = 5$) as a measure of cumulative exposure. $\mathbf{X}_i$ represents the time-invariant covariates on the student level such as gender, free lunch and English learner status, 6th grade ELA and math test scores, and indicator variables for four of the five cohorts, with the 2005-2006 cohort as the reference category. Finally, $\mathbf{U}_j$ represents the baseline control variables on the neighborhood level (census tract in grade 6) and includes police precinct fixed effects,

⁴ We also include drug and weapons crimes as time-varying covariates when estimating the effect of pedestrian stops and misdemeanor arrests on the subset of cohorts for which we observe these variables across the observation period. These results are substantively identical to the more parsimonious models and are not included.

population size, racial composition in terms of proportion Black, Asian, Latino and other residents, residential instability, and concentrated disadvantage.

These models provide unbiased and consistent estimates of marginal effects for the target population under three key assumptions. The first assumption is that the models for the conditional mean of the time-varying confounders are correctly specified. Misspecifying these models can lead to a weighted pseudo-population in which future treatments are orthogonal to the time-varying covariates without resembling the target population, leading to bias in estimates of the treatment effect for the population of interest (Zhou and Wodtke 2020). We mitigate these concerns by checking the robustness of our estimates to different model specifications for the time-varying covariates, where we 1) include a set of baseline confounders in the models for the time-varying covariates and 2) estimate similar models on a subset of a sample for which we have additional sets of measured time-varying covariates. The second assumption states that the specified balancing conditions are sufficient. We mitigate these concerns by assessing the robustness of our estimates when we include interactions between the time-varying covariates and higher-order terms in the models for the time-varying confounders. Finally, similar to other research using marginal structural models, our estimates are subject to the sequential ignorability assumption, stating that, conditional on past treatments and observed confounders, the treatment at each time point is unconfounded by unobserved confounders including unobserved individual characteristics. Compared to other recent research on the effects of neighborhood, or school-level exposure to policing, our approach comes with tradeoffs. It allows us to examine the effects of long-term exposure to neighborhood policing stops while accounting for the dynamic relation between policing and crime but does not leverage more plausibly exogenous sources of variation from quasi-experimental designs such as Legewie and Fagan (2019), Bacher-Hicks and de la Camp (2020) or Ang (2021).

Gap-Closing Estimates

In the second step of our analyses, we use gap-closing estimands to determine how the racial/ethnic gap in high school graduation would change depending on different levels of exposure to neighborhood policing (Lungberg 2021; VanderWeele and Robinson 2014). Though related to Kitagawa-Blinder-Oaxaca decompositions (Kitagawa 1955; Blinder 1973; Oaxaca 1973), gap-closing estimands are distinct in that they explicitly invoke a causal claim: they are

defined as the disparity in an outcome (such as high school graduation) we would expect across groups (such as race/ethnicity) when a sample of the population receives a counterfactual intervention to the treatment (such as exposure to neighborhood policing). The counterfactual treatment assignment can be either fixed to a certain value or stochastic.

In our analysis, we examine how the racial/ethnic gap in high school graduation would change under four counterfactual scenarios: 1) If we intervened so that all students experienced very low levels of neighborhood policing; 2) If a sample of students all experienced the same level of neighborhood policing as white students; 3) If the level of neighborhood policing was entirely determined by the level of crime; and 4) If the level of neighborhood policing was solely based on crime, but using the policing-crime relation for the last cohort in our sample. Over the study period, the use of SQF dramatically declined so that in later years the same number of violent crimes predict a lower level of policing.

Identifying gap-closing estimands directly builds on our estimation strategy discussed above. In particular, we convert the function to predict the outcome from the marginal structural model above to an estimate of the gap-closing estimand using the *g*-formula (Hernán and Robins 2020:166; Lundberg 2021). To implement this approach, we first use the outcome model to predict unobserved potential outcomes under all five possible values of the treatment variable (neighborhood police stops). We then calculate the group-specific estimates of the expected outcome under each counterfactual assignment rule by averaging over all observations in each group weighted by the sample weight and assignment probability for each treatment category. The difference in these group-specific estimates of the predicted outcome is an estimator of the gap-closing estimand and the standard errors are based on bootstrapping (for more details, see Lundberg 2021:18).⁵ Their causal interpretation is subject to the same assumptions discussed above.

⁵ Lundberg (2021) also proposes a doubly robust estimator that combines an estimator based on predicted outcomes as the one discussed here with an estimator based on predicted treatment probabilities. The doubly robust estimator is more robust to certain misspecifications. Our analysis relies on the predicted outcomes approach using the *g*-formula because it directly builds on our estimation strategy discussed above that is particularly suited for settings with time-varying treatment and controls.

Sample Restrictions and Missing Data

We restrict our analytical sample in several ways. First, we focus on white, African-American and Latino students because the sample size is sufficiently large to support our analysis. This restriction leaves us with 287,064 students across five cohorts. Second, our analyses exclude 55,887 students (19.47%) who leave NYC public schools before the end of our observational period because they either transfer to a private school, leave the NYC school district or are discharged for other reasons that are not related to graduation or dropout. This restriction is an important limitation of administrative school district records that raises concerns about selection out of the sample. We address this challenge by using inverse probability weighting (IPW) to control for various forms of attrition (for details, see Huber 2012). The weights are defined as the inverse of the predicted values from a logistic regression that predicts whether students remain in the sample using the same set of predictors as in the main analysis.

These restrictions leave us with an analytical sample of 231,177 students across five cohorts. The frequency of missing values is low for most variables ranging from almost 0 to 3%. However, it is as high as 15.5% for free lunch status and English learner status and around 6% for some other covariates. To address this issue, we use multiple imputation with 5 imputed datasets based on the chained equation approach (Van Buuren and Groothuis-Oudshoorn 2011). The imputation is based on a model that includes all relevant variables from the final analysis.

Results

[Table 2 about here]

We begin by describing racial/ethnic disparities in long-term exposure to neighborhood policing. The five cohorts in our study came of age during a period of changing policing policies in New York City. Table 2 presents the average number of Stop, Question and Frisk operations in student's residential environment (census tract) over a 5-year period (cumulative exposure) by

race/ethnicity and cohort.⁶ The average Black student in the 2005-2006 middle school cohort experienced 1,861 SQF operations in their census tract during middle and high school, or roughly 1.0 SQF operation per day. This cumulative exposure for Black students in the 2005-2006 cohort ranges from 319 stops for students in low policing neighborhoods (5th percentile) to 7,835 stops for students in high policing neighborhoods (95th percentile). Accordingly, some Black students were exposed to an average of 4.3 police stops in their census tract—a relatively small geographic area—every single day over this five-year period. For each subsequent cohort, cumulative exposure declined, reaching an average of 986 SQF operations for Black students in the 2009-2010 cohort. While SQF operations are likely underreported in later years (Braga, MacDonald, McCabe 2021), the decline reflects a substantial change in policing policy in NYC. Across the five cohorts, Latino students experienced slightly lower but overall similar levels of policing in their immediate residential environment. White students, however, were consistently exposed to substantially lower levels of policing. On average, white students in the 2005-2006 cohort were exposed to 568 police stops in their neighborhood over a five-year period, corresponding to 0.3 stops compared to 1.0 and 0.9 stops per day for Black and Latino students, respectively. Cumulative exposure among white students further decreased for subsequent cohorts, averaging 299 police stops for the 2009-2010 cohort. While the level of policing substantially declined over time, racial disparities in cumulative exposure remained consistent. Column five and six in Table 2 report the Black/white and Latino/white ratio in cumulative exposure to policing. For the 2005-2006 cohort, this ratio indicates that Black students were exposed to 3.27 times the number of police stops in their neighborhood as white students over middle and high school, which remained remarkably constant across cohorts despite dramatic declines in the use of SQF.

[Table 3 about here]

[Figure 1 about here]

⁶ Note that the descriptive statistics presented here focus on neighborhood police stops during the entire school year and not just the fall term as the measure used in the regression analysis to ensure a clear temporal order between the time-varying treatment and confounder. Table 1 presents descriptive statistics for the measures used in the analysis.

In the next step of analysis, we estimate the effect of cumulative, long-term exposure to SQF on high school graduation. Table 3 shows the results from marginal structural models for white, Black and Latino students and Figure 1 visualizes the key coefficients. The findings show that long-term exposure to SQF is associated with a decreased likelihood of graduating from high school for Black and Latino students, whereas the evidence for white students is mixed. Using “very low” exposure as the reference category (1st quintile), we find a gradually increasing negative effect size for higher levels of exposure. For Black students, “low” compared to “very low” exposure to police stops during middle and high school is associated with a 2.3 percentage point lower graduation rate. “Average” exposure is associated with a 5.1 percentage point lower graduation rate, “high” exposure with a 6.6 percentage point lower graduation rate and “very high” exposure with an 8.8 percentage point lower graduation rate. To put the size of this effect into perspective, a 6.6 and 8.8 percentage point lower graduation rate corresponds to an 8.4% and 11.1% decrease in the graduation rate for Black students (72.4% and 70.2% compared to the observed graduation rate of 79.0%). The Black-white gap in high school graduation is 11.3 percentage point in our sample, such that the estimated effect size corresponds to a substantial proportion of that gap.

Latino students similarly experience a negative effect of police exposure on high school graduation, but the size of the effect is somewhat smaller. The results reported in Table 3 and illustrated in Figure 1 suggest that “high” compared to “very low” exposure to police stops is associated with a 4.9 percentage point lower graduation rate for Latino students, and “very high” exposure with a 4.7 percentage point lower graduation rate. The difference in the effect size between Black and Latino students is meaningful but only statistically significant for “very high” exposure (see “B-L” column in Table 3). For white students, the sample size is insufficient to draw clear conclusions, particularly for higher levels of exposure. While the point estimates indicate that white students experience a smaller but still negative effect of cumulative exposure to policing, the uncertainty in the estimates is large and the estimates are not statistically significant. However, we do find statistically significant differences in the coefficient estimates between Black and white, and Latino and white students for most levels of exposure. Additional analysis presented in Table A3 show similar patterns with somewhat smaller effect sizes for neighborhood exposure to low-level arrests on high school graduation, reaffirming the results with a different measure of proactive neighborhood policing.

Table 4 compares the effect of cumulative exposure to police stops for Black students with the effect of exposure over a single year in middle or high school. Table A4 presents the same results for white and Latino students. Overall, the effect size of cumulative exposure is larger compared to the effect of exposure during a single year in middle or high school, but the magnitude and statistical significance of these differences in effect size varies somewhat across the level of the treatment. Compared to middle school exposure, the effect of cumulative exposure on high school graduation is consistently larger and this difference is statistically significant at the 0.01 level for the coefficients “Average”, “High” and “Very High” compared to “Very Low” SQF exposure. Comparing high school with cumulative exposure to SQF, similarly shows that the effect size of cumulative exposure is either essentially the same (“Low” compared to “Very Low”) or larger. However, the differences in effect size are only statistically significant for “Very High” compared to “Very Low” exposure. These findings highlight the importance of focusing on long-term exposure to policing to understand the consequences of sustained experience with the police over an extended period time.

Gap-Closing Estimands

[Figure 2 about here]

The analyses so far reveal a large and statistically significant negative effect of long-term exposure to neighborhood policing on high school graduation. However, it remains unclear whether or not neighborhood policing plays a meaningful role in explaining the Black-white and Latino-white gap in high school graduation and whether interventions to policing would reduce the gap. Figure 2 shows that the Black-white and Latino-white gaps is about 11.3 and 11.7 percentage points, respectively, and persist across the five cohorts in our study. In the next part of the analysis, we use gap-closing estimands to determine how this racial/ethnic gap in high school graduation would change if we intervened to assign some students to a lower (or higher) level of exposure to neighborhood police stops under different counterfactual scenarios. Table 5 presents the results.

[Table 5 about here]

First, we examine how the racial/ethnic gap in high school graduation would change under a deterministic scenario, where we intervene to assign a sample of students to the lowest level of policing. Assigning all students to the lowest level of policing, the Black-white and Latino-white disparities would be reduced to 7.0 and 8.8 percentage points. This corresponds to a 38.6% and 25.4% reduction of the gap, highlighting the degree to which the racial/ethnic gap in high school graduation is a causal consequence of neighborhood policing.

Second, we examine how the racial/ethnic gap in high school graduation would change if we intervened so that a sample of students all experienced the same level of neighborhood policing as white students. The assignment rule is stochastic and based on the distribution of white students across the five categories of our treatment variable with the following assignment probabilities: 51.4% for the first quintile, 27.6% for the second, 13.0% for the third, 5.3% for the fourth and 2.8% for the fifth quintile (see Table A5 for the assignment probabilities under each of the four interventions discussed here). Under this intervention, the Black-white and Latino-white disparities would be reduced to 8.2 and 9.7 percentage points, respectively, which corresponds to a 27.8% and 17.5% reduction of the gap. This reduced racial/ethnic gap in high school graduation rates is a result of both a larger effect of neighborhood policing on Black students and a substantial reduction in cumulative exposure for both Black and Latino students when assigning them to the distribution of exposure among white students. It indicates that group differences in exposure explain a substantial part of the gap in high school graduation, but important differences remain.

Third, we assess how the racial/ethnic gap in high school graduation would change if we intervened so that the level of neighborhood policing is entirely determined by the level of crime. For this purpose, we use student-level data from all five cohorts in our sample to predict cumulative exposure to police stops as a function of neighborhood crime using an ordered logistic regression. This model allows us to derive the assignment probabilities for all student in the sample using the predicted probabilities for each of the five categories of the treatment variable. Table A5 presents the average assignment probabilities by race/ethnicity. The results of the gap-closing estimates presented in Table 5 indicate that this intervention would do little to close the racial/ethnic gap in high school graduation. In particular, the Black-white and Latino-white disparities would remain at 11.2 and 11.7 percentage points, respectively, which corresponds to a change of 1.1% and 3.4%. The reason for this finding is that basing policing on

crime alone changes little about racial/ethnic disparities in police exposure as documented in Table A5 for intervention 3.

Lastly, we focus on a similar intervention in which police exposure is solely a function of crime. But instead of using data from all cohorts to establish the relation between police stops and crime exposure, we use data from the 2009-2010 cohort—the last cohort in our study. This cohort came of age during a period of substantially lower levels of police stops (see Table 2). Compared to the previous intervention, cumulative exposure to policing under this intervention is lower across all racial/ethnic groups simply because the overall number of police stops dramatically declined over time: the same level of neighborhood crime predicts a lower level of police exposure (see Table A5). Under this intervention, the Black-white and Latino-white disparity in high school graduation would be 10.2 and 10.9 percentage points respectively, which corresponds to a modest reduction of 10.3% of the Black-white gap and slightly smaller change of 6.9% for the Latino-white gap. This counterfactual scenario informs two important issues. First, it speculates about a world without a spike in the use of police stops during the 2000s and early 2010s. SQF is one of the most prominent and controversial policing programs of the recent past. A generation of minority youth in New York City and other places with similar programs was exposed to startlingly high levels of police stops in their residential environment. Our results suggest that without the dramatic increase in the use of SQF, the Black-white gap in high school graduation would be 10.2 percentage points smaller, with higher graduation rates across all three groups. From a policy perspective, the intervention is informative because it explores the expected disparities in high school graduation under a largely race neutral allocation of police resources. The counterfactual intervention is more realistic because police exposure is directly linked to crime, empirically informed by current levels of police stops and continues to show racial/ethnic disparities in police exposure. However, it also assumes that the higher level of police stops in earlier years did not help reduce crime.

Conclusion

Policing is a divisive political issue central to debates about racial inequities. A growing body of research contributes to this debate and examines the social consequences and costs of policing for the health, education and civic engagement of minorities. The results presented in this article

contribute to this work by providing the first systematic assessment of long-term exposure to neighborhood policing. A longitudinal perspective highlights how unequal exposures to neighborhood policing cumulate over adolescence and allows us to disentangle the dynamic relationship between neighborhood policing, crime, and educational attainment.

Using administrative data from the New York City Department of Education and the New York City Police Department, we follow five cohorts of 231,177 NYC public school students over an eight-year period from middle to high school. First, we document racial and ethnic disparities in long-term exposure to neighborhood policing over key developmental periods. The longitudinal perspective crystallizes racial and ethnic disparities in exposure to neighborhood policing with profoundly different experiences for Black, Latino, and white youth. Similar to the way in which Massey and Denton (1993; also see Peterson and Krivo 2010) describe the lack of overlap in neighborhood conditions experienced by white and Black people in urban areas, a high level of neighborhood policing experienced by white students is comparable to the average experience for Black and Latino students. These disparities have important implications for our understanding of urban inequality and replicate disparities in other forms of criminal justice contact such as arrest or incarceration (Weaver, Papachristos, and Zanger-Tishler 2019; Wildeman 2009).

Second, we examine the effect of cumulative exposure to policing across middle and high school on high school graduation using innovative methods for time-varying treatment effects. These models address the dynamic relation between neighborhood crime and policing, capturing the full effect of policing on educational attainment without “controlling away” the potentially beneficial effect of policing that operates indirectly through reductions in violent crime. The results of our analysis show that the effect of long-term exposure to SQF is large and statistically significant for Black students and, to a smaller extent, for Latino students. Furthermore, our analyses show that the effects of cumulative exposure matter above and beyond the effects of differences in exposure observed during single-year periods at different developmental stages. These findings show that ignoring cumulative, long-term exposure to neighborhood policing underestimates the full extent to which policing impacts educational outcomes. They demonstrate that Black and Latino youth are more likely to experience aggressive forms of neighborhood policing throughout adolescence and are disproportionately impacted by this exposure. Together, the racial/ethnic differences in both exposure to and the effect of long-term

neighborhood policing create a double disadvantage particularly for Black students that perpetuate systematic and institutionalized inequalities. This double disadvantage constitutes a form of “hobbling” (Justice 2021), a social process that restricts demographically targeted children’s right to a public education limiting their social mobility, disempowers race-class subjugated communities (Weaver and Geller 2019) and sustains structural racism.

While administrative school district records allow us to create a unique longitudinal dataset that tracks five cohorts of students during middle and high schools, administrative data lack detailed information on underlying mechanisms. It does not allow us to examine the two key processes, institutional trust and trauma, that link long-term exposure to neighborhood policing to high school graduation. Future research should address this limitation with a specific focus on cumulative exposure to policing.

Our research echoes the notion that residential environments have an important effect on children’s life chances (Chetty et al. 2014; Sampson 2012). They show that neighborhood policing can be an important contributor to the negative effects of growing up in a disadvantaged neighborhood on children’s high school graduation and highlight neighborhood policing practices as one of many dimensions through which residential environments can affect individual’s outcomes (Harding et al. 2010). In addition to considering how the absence of positive mechanisms like collective efficacy contribute to the detrimental effects of neighborhoods on their residents’ well-being, future research should also consider how the presence of negative mechanisms such as systems avoidance and the erosion of trust in state institutions disempower their residents, shaping their perceptions of neighborhoods (Bell 2020).

Aside from focusing on disparities in and the effect of long-term exposure to neighborhood policing, this article uses novel gap-closing estimands (Lundberg 2021) to examine several counterfactual scenarios that help us understand how the racial/ethnic gap in high school graduation would change for a sample of students if exposure to neighborhood policing were equalized or solely based on neighborhood crime. This analysis is the first to assess whether or not neighborhood policing plays a meaningful role in explaining the Black-white and Latino-white gap in high school graduation and whether changes in policing policy would reduce the gap. The findings show that assigning a sample of Black and Latino students to the same level of neighborhood policing as white students would reduce the Black-white gap in high school graduation by 27.8% and the Latino-white gap by 17.5%. Alternatively, we show

that if neighborhood policing was solely a function of violent crime, the Black-white gap would close by up to 10.8% but only if the level of police stops is lower than at the peak of the SQF program.

From a scientific perspective, these findings indicate that neighborhood policing accounts for almost a third of the Black-white gap in high school graduation and to a smaller extent for the Latino-white gap. This assessment, however, is limited by the far-reaching and sometimes implausible nature of claims about a radically different world. From a policy perspective, the gap-closing estimands estimate the expected disparities in high school graduation under a largely race neutral allocation of police resources and suggests that such an intervention would make a meaningful but not large difference for disparities in high school graduation. Overall gap-closing estimands are a novel and innovative way to explore the role of policing policy for an important and consequential aspect of racial/ethnic inequalities-the gap in high school graduation. Building on Lundberg's work (2021), our article presents one of the first applications of this approach to a concrete applied problem that is relevant for population science and beyond.

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Tables and Figures

Table 1 - Descriptive Summary Statistics for Key Variables

	All Students	Black	White	Latino
Students	231,177	85,490	36,396	109,291
Percent High School Graduation	80.6%	79.0%	90.3%	78.6%
<i>Cumulative Exposure to Policing and Crime</i>				
Neighborh. Police Stops (Fall)	794.8	950.9	296.9	838.5
Neighborh. Police Stops (Fall, categorical)				
Very Low (1 st quintile)	20.0%	12.8%	51.4%	15.3%
Low (2 nd quintile)	20.0%	17.2%	27.6%	19.6%
Average (3 rd quintile)	20.0%	21.5%	12.9%	21.2%
High (4 th quintile)	20.0%	23.5%	5.3%	22.2%
Very High (5 th quintile)	20.0%	25.0%	2.8%	21.8%
Neighborh. Low-Level Arrests (Fall)	480.5	520.6	194.6	544.2
Neighborh. Violent Crime (Spring)	72.6	83.4	27.7	79.1
Neighborh. Property Crime (Spring)	91.5	93.1	78.6	94.5
Neighborh. Misdemeanors Crime (Spring)	441.1	467.9	257.2	481.5
School Exposure to Police Stops (full year)	726.5	840.8	354.8	760.7
<i>Neighborhood Characteristics (measured at t=1)</i>				
Avg. Population	4,875	4,570	4,671	5,180
Avg. Concentrated Disadvantage	0.5	0.7	-0.5	0.6
Avg. Residential Instability	0.3	0.3	-0.5	0.6
Avg. Percent White	20.7%	8.6%	61.6%	16.6%
Avg. Percent Black	32.6%	58.0%	6.4%	21.6%
Avg. Percent Latino	36.2%	26.9%	16.6%	50.0%
Avg. Percent Asian	8.3%	4.2%	13.8%	9.7%
<i>Student Characteristics</i>				
Percent Female	51.3%	52.9%	49.1%	50.8%
Percent Free/Reduced Lunch	83.4%	89.7%	54.0%	88.4%
Percent English Learner Status	25.3%	3.5%	19.1%	44.5%
Avg. ELA Score	654.1	652.2	669.6	650.5
Avg. Math Score	666.1	660.9	687.3	663.2

Note: All continuous variables are standardized for the analysis.

Table 2 - Mean Cumulative Exposure to SQF over 5 Years by Race and Cohort

Cohort	Black	Latino	White	Black/White Ratio	Latino/White Ratio
2005-2006	1,861 (319, 7835)	1,689 (326, 6384)	568 (124, 2236)	3.27	2.97
2006-2007	1,877 (342, 7403)	1,726 (319, 6484)	573 (139, 2423)	3.27	3.01
2007-2008	1,729 (330, 6335)	1,527 (292, 5596)	485 (114, 2267)	3.56	3.15
2008-2009	1,367 (270, 4923)	1,203 (233, 4523)	413 (99, 1785)	3.31	2.91
2009-2010	986 (197, 3713)	866 (158, 3286)	299 (69, 1312)	3.30	2.90

Note: 5th percentile and 95th percentile shown in parentheses.

Table 3 – Marginal Structural Models: Effect of Cumulative, Long-Term Exposure to Neighborhood Police Stops on High School graduation by Race/Ethnicity

	White	Black	Latino	Difference in Effects ⁺		
				W-B	W-L	L-B
Cumulative SQF Exposure (Ref.: Very low)						
Low	-0.012** (0.005)	-0.023*** (0.006)	-0.024*** (0.005)	0.011 (0.007)	0.012 (0.007)	-0.001 (0.007)
Average	-0.012 (0.006)	-0.051*** (0.007)	-0.041*** (0.006)	0.039*** (0.010)	0.029*** (0.008)	0.010 (0.010)
High	-0.021* (0.010)	-0.066*** (0.009)	-0.049*** (0.007)	0.045*** (0.013)	0.028* (0.013)	0.017 (0.011)
Very High	-0.034 (0.018)	-0.088*** (0.013)	-0.047*** (0.010)	0.053* (0.022)	0.013 (0.020)	0.041* (0.017)
<i>Student characteristics</i>						
Female	0.032*** (0.004)	0.056*** (0.005)	0.038*** (0.004)	-0.024*** (0.007)	-0.006 (0.005)	-0.018** (0.006)
Free or reduced lunch	-0.039*** (0.004)	-0.043*** (0.010)	-0.032*** (0.005)	0.004 (0.010)	-0.007 (0.006)	0.012 (0.010)
English Lang. Learner	0.023*** (0.005)	0.038 (0.023)	0.026*** (0.004)	-0.014 (0.025)	-0.003 (0.006)	-0.012 (0.023)
ELA Score at t0	0.013*** (0.002)	0.048*** (0.003)	0.042*** (0.003)	-0.035*** (0.004)	-0.029*** (0.003)	-0.006 (0.004)
Math Score at t0	0.063*** (0.002)	0.101*** (0.003)	0.110*** (0.003)	-0.038*** (0.004)	-0.047*** (0.003)	0.009* (0.004)
School Police Stops (log)	-0.013*** (0.004)	-0.015** (0.004)	-0.002 (0.004)	0.002 (0.006)	-0.011* (0.005)	0.013* (0.006)
<i>Neighborhood characteristics</i>						
Population Size	0.007** (0.003)	0.004 (0.005)	0.004 (0.003)	0.003 (0.006)	0.003 (0.004)	-0.001 (0.007)
Residential Instability	-0.002 (0.003)	0.009 (0.005)	0.007 (0.004)	-0.011 (0.006)	-0.009 (0.005)	0.013* (0.006)
Concentrated Disadv.	-0.008 (0.007)	-0.013* (0.005)	-0.013** (0.004)	0.004 (0.008)	-0.004 (0.008)	0.000 (0.007)
Percent Black	-0.031*** (0.009)	0.017 (0.012)	-0.001 (0.005)	-0.048*** (0.013)	-0.030** (0.010)	-0.018 (0.012)
Percent Asian	-0.002 (0.002)	0.000 (0.009)	0.002 (0.002)	-0.002 (0.009)	-0.004 (0.003)	0.002 (0.009)
Percent Latino	-0.010 (0.007)	0.006 (0.010)	0.002 (0.005)	-0.016 (0.013)	-0.012 (0.009)	-0.005 (0.010)
Percent Other	-0.005 (0.003)	-0.001 (0.002)	-0.004 (0.003)	-0.004 (0.004)	-0.001 (0.004)	-0.002 (0.003)
Cohort & Precinct FE	✓	✓	✓	✓	✓	✓
Observations	36,396	85,490	109,291	231,177	231,177	231,177

+ The effect differences across groups are based on fully interactive models. *P < 0.05, **P < 0.01, ***P < 0.001

Figure 1 - Effect of Cumulative, Long-Term Exposure to Neighborhood Police Stops on High School graduation by Race/Ethnicity

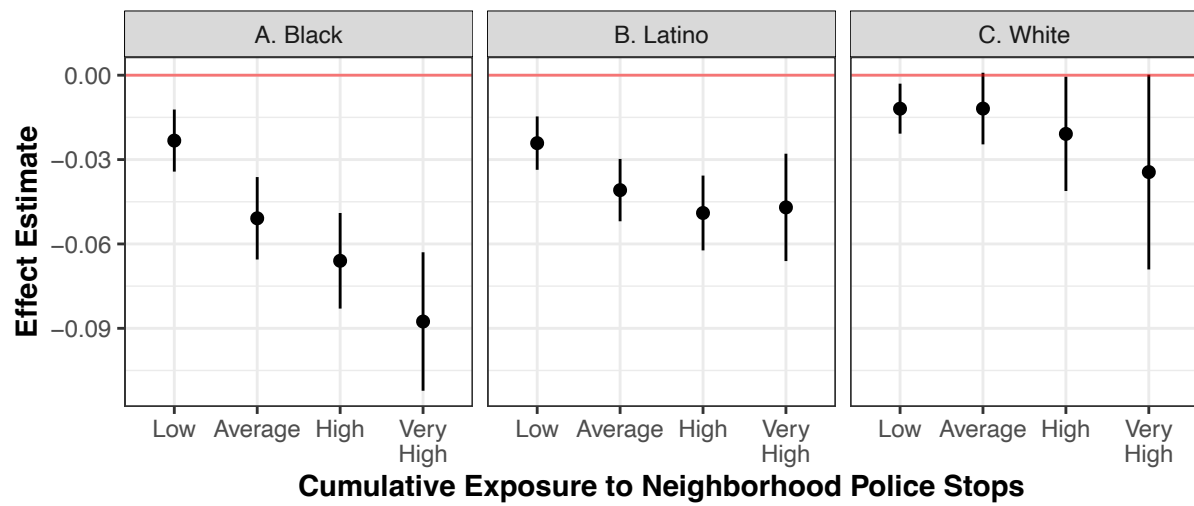


Table 4 – Effect of Cumulative Exposure compared to Middle and High School Exposure (Black Students)

	Cumulative Exposure	Middle School Exposure (t=1)	High School Exposure (t=3)
SQF Exposure (Ref.: Very Low)			
Low	-0.023*** (0.006)	0.001 (0.011)	-0.024** (0.009)
Average	-0.051*** (0.007)	0.005 (0.011)	-0.038*** (0.010)
High	-0.066*** (0.009)	-0.004 (0.012)	-0.050** (0.011)
Very High	-0.088*** (0.013)	-0.015 (0.014)	-0.054*** (0.014)
Student and Neighborhood Characteristics	✓	✓	✓
Cohort Fixed Effect	✓	✓	✓
Precinct Fixed Effect	✓	✓	✓
Observations	85,490	85,490	85,490

Note: The difference in effect size between cumulative and middle school exposure is statistically significant at the 0.01 level for the coefficients “Average”, “High” and “Very High”. For cumulative compared to high school exposure, the difference in effect size is statistically significant at the 0.05 level for the coefficient “very high”.

*P < 0.05, **P < 0.01, ***P < 0.001

Figure 2 – High School Graduation Rates across Cohorts and Racial/Ethnic Groups

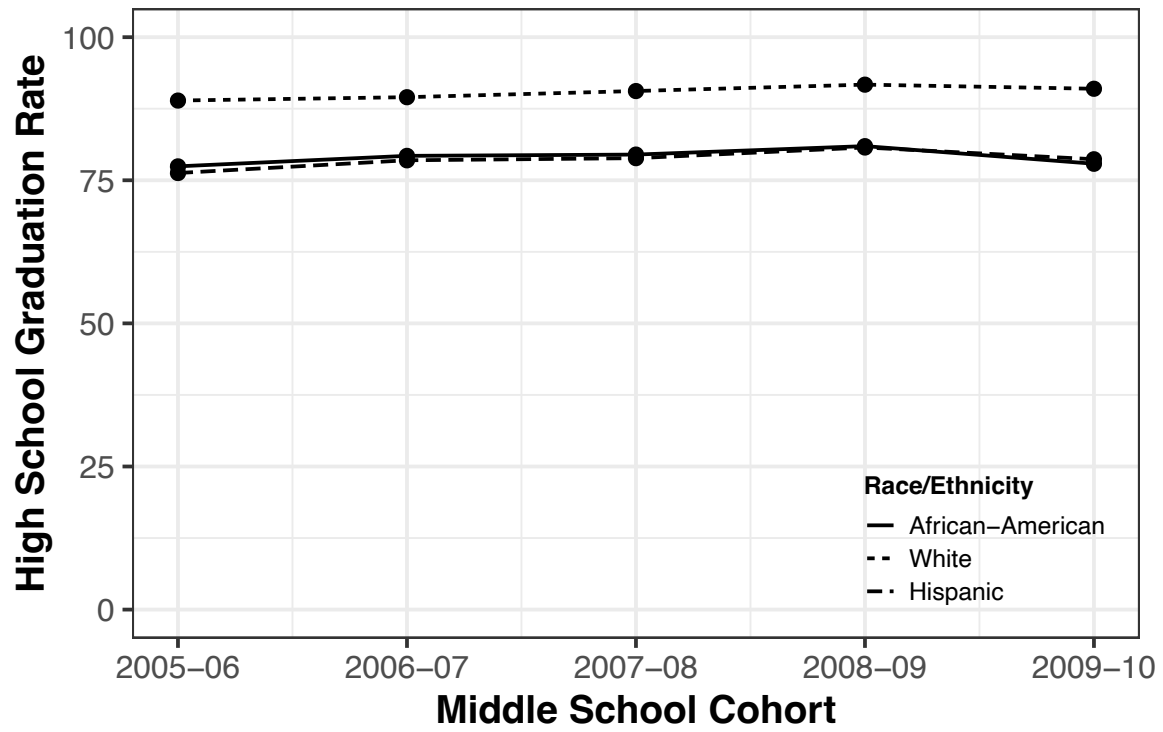


Table 5 – Gap closing estimands with 95% Bootstrapped Confidence Intervals

	Black	Latino	White	B-W	L-W
Observed graduation rate	79.0%	78.6%	90.3%		
Observed gap				11.3	11.7
<i>(1) Intervention: Very low exposure to policing</i>					
Counterfactual grad. rate	84.0% (83.2, 85.2)	82.2% (81.5, 83.0)	91.0% (90.4, 91.3)		
Counterfactual gap				7.0 (5.6, 7.7)	8.8 (7.7, 9.5)
Percent gap closed				38.6% (32.4, 50.9)	25.4% (19.5, 34.3)
<i>(2) Intervention: White exposure to policing</i>					
Counterfactual grad. rate	82.1% (81.6, 82.9)	80.7% (80.2, 81.1)	90.3% (90.0, 90.6)		
Counterfactual gap				8.2 (7.4, 8.7)	9.7 (9.1, 10.2)
Percent gap closed				27.8% (23.2, 34.5)	17.5% (13.4, 22.0)
<i>(3) Intervention: Policing as function of crime</i>					
Counterfactual grad. rate	79.0% (78.7, 79.5)	78.9% (78.5, 79.2)	90.3% (89.9, 90.6)		
Counterfactual disparity				11.2 (10.7, 11.7)	11.7 (10.9, 11.9)
Percent gap closed				1.1% (-2.3, 5.1)	3.4% (-.4, 6.1)
<i>(4) Intervention: Policing as function of crime based on 2009-2010 cohort</i>					
Counterfactual grad. rate	80.4% (80.0, 80.9)	79.6% (79.3, 79.9)	90.5% (90.1, 90.8)		
Counterfactual gap				10.2 (9.5, 10.6)	10.9 (10.4, 11.3)
Percent gap closed				10.3% (7.6, 15.4)	6.9% (4.0, 10.5)

Note: “Proportion gap closed” is defined as (Observed - Counterfactual) / Observed. Table A2 presents the average assignment probabilities by race/ethnicity under each of the four interventions.