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Early childhood education and handgun carrying, serious fighting, and assault charges: a retrospective cohort study

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Abstract

High-quality early childhood education may buffer against social and structural drivers of interpersonal violence. We examined the association of Head Start—a large-scale early childhood education program for low-income children, launched in 1965 as part of the War on Poverty—with handgun carrying, serious fighting, and assault charges among 4281 individuals born between 1980 and 1984 in the National Longitudinal Survey of Youth 1997. We found that attending Head Start vs other childcare was associated with 0.77 times the risk of handgun carrying by age 31 (95% CI: 0.60, 0.99) and 0.79 times the risk of serious fighting by age 24 (95% CI: 0.64, 0.98) among Black males. No reduction in the risk of outcomes was observed among other subpopulations or when comparing Head Start with solely parental childcare. Expanding access to high-quality early childhood education programs may reduce later-life handgun carrying and serious fighting among those at highest risk, thus reducing racialized disparities. Results suggest that early-life investments in the social, economic, and human capital of structurally disadvantaged children and families may be effective and equitable tools to prevent violence and firearm-related harms.

Lay Summary

The likelihood of engaging in interpersonal violence and related risk behaviors (eg, handgun carrying) increases in adolescence and young adulthood, especially for Black males. However, risk for these behaviors is often rooted in early childhood experiences, including the resources children had and the environments to which they were exposed. Public health and policy interventions that expand access to resources and promote optimal development—particularly for children growing up in disadvantaged families and communities—may therefore prevent violence. We studied outcomes of individuals in adolescence and young adulthood who, during ages 3–5, either attended Head Start (a large-scale, high-quality preschool program for low-income children), other childcare, or solely parental childcare. We found that Black males who attended Head Start vs other childcare had a lower risk of handgun carrying and serious fighting. There were generally no associations among other subpopulations (eg, White individuals) or when comparing Head Start with solely parental childcare. Our findings suggest that high-quality preschool programs for low-income children may reduce racial disparities in violence.

Key words: firearms; violence; early childhood education; social policy.

Key Takeaways

- Attending Head Start vs other childcare during ages 3–5 was associated with 23% lower handgun-carrying risk (by age 31) among Black males.
- Attending Head Start vs other childcare during ages 3–5 was associated with 21% lower serious fighting risk (by age 24) among Black males.
- Findings for other intersectional groups were null, or were sensitive to how we approximated childhood poverty.

Introduction

Interpersonal violence is a significant public health and public safety problem in the United States. In 2022, homicide was a leading cause of mortality, accounting for 24 849 deaths, 79% of which involved firearms.[1] That year, there were 6.6 million nonfatal violent victimizations nationally, including rape or sexual assault, robbery, and physical assault.[2]

The causes of interpersonal violence are multifaceted but many are rooted in the unequal distribution of power, resources, and opportunities.[3] These flexible resources are shaped by social and structural forces (eg, systems of oppression, policies) and become embodied over time—often beginning in childhood—to affect risk for violence.[4,5] This is reflected in the population distribution of interpersonal violence, with

young Black males from disinvested communities disproportionately affected.[1,6] Pathways of embodiment include race-based discriminatory housing and land-use policies that have concentrated poverty, restricted access to resources, and increased exposure to environmental hazards and trauma,[7-9] which can increase violence risk, especially among young people, via psychosocial, economic, and bio-behavioral mechanisms.[10-12] For example, exposure to trauma and environmental hazards can alter brain development, increase hypervigilance, bias attention towards negative emotional cues, and affect emotion regulation.[13-16] Such behavioral and neurocognitive changes can, in turn, affect risk of violence and violence-related behaviors (eg, handgun carrying).[17,18]

Interventions that expand access to resources—especially in early childhood and for structurally marginalized groups—hold promise in preventing violence. One such intervention is high-quality early childhood education, which is designed to prevent and/or buffer against early adversity, improve access to resources, and promote optimal development.[19] While research suggests that early childhood education programs reduce crime generally and risk factors that may lie on the path to interpersonal violence,[20] no studies to our knowledge have examined firearm-related behaviors and few have examined interpersonal violence specifically. Of those that examined interpersonal violence, most have studied relatively small-scale and/or intensive programs (eg, in single cities/towns, with low student-to-teacher ratios and highly trained staff).[21-27] While research on such programs is valuable, it may not generalize to larger programs with different models. Further, because of homogenous study populations, prior research has had limited ability to examine whether associations differ by individuals' social identities (eg, 93%–100% of participants in the High Scope/Perry Preschool Program, Carolina Abecedarian Project, and Chicago Child–Parent Centers were Black).[26]

Head Start began in 1965 as part of the War on Poverty and is the nation's oldest and largest early childhood education policy. It is a federally funded, locally run preschool program for low-income children ages 3–5 years that incorporates comprehensive education, health, and social services, including supports for parents (see the Appendix "About Head Start" for details).[28] Prior research suggests that Head Start has a range of benefits,[29] from increasing prosocial behaviors, educational attainment, and employment to reducing externalizing problems, substance use, and crime.[30-32] The lack of research on large-scale early childhood education programs such as Head Start and violence or firearm-related outcomes is a notable and increasingly recognized gap,[20] considering the distinct costs and potential etiologies of these outcomes.

We examined the association of Head Start with handgun carrying, serious fighting, and assault charges. As depicted in our conceptual model (Figure S1), we hypothesized that Head Start (vs other childcare and parental care) improves children's and families' access to resources (ie, material, cognitive, socioemotional) in ways that reduce interpersonal violence and related risk behaviors, but with effects that depend on social identities. In particular, we hypothesized that males of color would experience the greatest benefits of Head Start based on prior research suggesting that early childhood education has greater benefits for those at greater risk of adverse outcomes[25,30,33-37] and in accordance with resource substitution theory, which suggests that more marginalized populations experience greater benefits from education because their access to other flexible resources is more restricted.[38,39]

Data and methods

Study design, setting, and population

This retrospective cohort study used data from the National Longitudinal Survey of Youth 1997 (NLSY97),[40] a nationally representative longitudinal survey of the civilian, non-institutionalized population born between 1980 and 1984 and living in the United States in 1997. Surveys were administered annually from 1997 to 2011 and every other year thereafter through 2021 (74.7% retention).[41]

The NLSY97 used stratified multistage area probability sampling, with independent selection. Eligible households were selected from primary sampling units (Black and Hispanic populations were oversampled), and all eligible youth per household were invited to participate. Additional details are provided elsewhere.[42]

Questions were asked of NLSY97 respondents, and, in the first wave, respondents' parents, via a computer-assisted system administered by the interviewer, in-person or over the phone in English or Spanish. A biological parent was selected for the parent questionnaire if possible; otherwise, another adult household member was selected per predetermined criteria (hereafter, we refer to the parent questionnaire respondent as "parent").[43]

Of the 8984 individuals in NLSY97, we excluded respondents who first moved to the United States after age 5 ($n = 352$) as they would not be eligible for Head Start (a preschool program for children ages 3–5). For our primary analysis, we further limited our sample to the 4281 respondents whose responding parent had a high school degree or less, as this group was more likely to be in poverty and thus eligible for Head Start (in NLSY97, 75% of Head Start attendees' parent had a high school degree or less). We used parental education as an imperfect proxy for Head Start eligibility because early childhood income/poverty (the main Head Start eligibility criterion) was not measured in NLSY97, education is a common indicator of socioeconomic status,[44] and it is important to choose proxies for Head Start eligibility that are least likely to be affected by Head Start (ie, on the causal pathway). Specifically, we used parental degree attainment (ie, no more than a high school degree) for our primary analysis because —while it was measured at the first wave in 1997—it is less likely to be affected by Head Start than income measured at the first wave (which is likely a poor proxy for income in the early 1980s).[45,46] It also offers a larger sample size than limiting to those whose parent had less than a high school degree. Sensitivity analyses for other proxies are described below.

Exposure

Parents were asked whether and at what ages from 0–5 years their child spent 20 or more hours a week in childcare, defined as "any care given by someone other than a parent. Childcare includes care by relatives, babysitters, and nannies. It also includes time when the child attends daycare centers or preschools." Then, parents were asked: "Did [name of youth] ever attend an official, government sponsored Head Start program? (interviewer: Head Start is a federally supported preschool program for low-income families.)" If parents answered "Yes," they were asked "at which ages did [this youth] attend Head Start? (select all that apply)." The number of weeks spent in Head Start or other childcare was not asked.

We created 3 mutually exclusive groups: respondents whose parent indicated they (1) ever attended Head Start during ages

3–5 years, (2) ever spent 20+ hours per week in childcare but never attended Head Start during ages 3–5 years (ie, other childcare), and (3) never spent 20+ hours per week in childcare and never attended Head Start from ages 3–5 years (ie, solely parental childcare).

Outcomes

Outcomes were age at first self-reported handgun carrying, serious fighting, and assault charges from ages 12 and older.

Handgun carrying was measured at each wave from 1997–2011 with the following questions: "Have you ever carried a hand gun?," with yes/no response options; "How old were you when you first carried a hand gun?," with age response options; and "Have you carried a hand gun since the last interview on [date of last interview]?," with yes/no response options. Handgun was defined as "any firearm other than a rifle or shotgun" and, beginning in 2004, the question specified "Please don't include times you carried a handgun because it was part of your work duties."

Serious fighting was measured from 1997–2003 with the following questions: "Have you ever attacked someone with the idea of seriously hurting them or have a situation end up in a serious fight or assault of some kind?," with yes/no response options; "How old were you the first time you did this?," with age response options; and "Since the last interview on [date of last interview], have you attacked someone with the idea of seriously hurting them or have had a situation end up in a serious fight or assault of some kind?," with yes/no response options.

Assault charges were measured from 1997–2021 with questions about ever being arrested (yes/no response options), year of arrest (year response options), and charges for each arrest (yes/no response options for specific charges). We focused on charges for "assault, such as battery, rape, aggravated assault, manslaughter." For wave 1, respondents were asked about their first and most recent arrest. In waves 2–6, respondents were asked about each arrest since the last interview. In waves 7–20, respondents with fewer than 4 arrests since the last interview were asked about each arrest (like waves 2–6), but respondents with 4 or more arrests since the last interview were only asked about the year of their first and most recent arrest since the last interview and whether they had—at any point since the last interview—been charged with assault. We attributed the year of assault charge to the first arrest since the last interview for those with 4 or more arrests since the last interview in waves 7–20.

For each outcome, we created a variable representing the age of first outcome (ie, handgun carrying, serious fighting, assault charges from ages 12–31, 12–24, and 12–41, respectively), which was modeled as time to event (binary variable indicating whether the event occurred by each age) in analyses. Additional information about survey questions and outcome operationalization is shown in Table S1.

Modifiers

We examined individual-level modification by respondent sex, race, and ethnicity, analyzing the categories used by NLYS97. We conceptualized sex (male, female) as a proxy for lived and perceived gender (these constructs, which are distinct from sex,[47] were not measured), and race and ethnicity as socially constructed, historically contingent indicators of systemic (dis)advantage.[48] Race (American Indian, Eskimo, Aleut;

Asian or Pacific Islander; Black; something else; White), ethnicity (Hispanic or Latino), and sex were measured at wave 1 per household informants' identification; sex was verified and corrected (as needed) in wave 1 by respondents and their parent. Due to small sample sizes and interpretability, we categorized race as Black and White (whether Hispanic or non-Hispanic), excluding other races, for modification analyses.

Covariates

We selected confounders per our directed acyclic graph (DAG) (Figure S2) and available data. Confounders were measured at the first survey wave and—when applicable and possible—referenced the period when respondents were 0–2 years (Table S1). Minimally adjusted models included the following: race, ethnicity, sex, race–sex and ethnicity–sex interactions, parental and grandparental educational attainment, parental employment, parental receipt of government aid, parental marital status, and parental education–marital status interaction. Fully adjusted models included all variables in the minimally adjusted model, plus whether the respondent spent 20+ hours per week in childcare prior to age 3, respondent disability prior to age 3, respondent birth year (to account for cohort effects), age of respondent's biological mother when respondent was born, whether respondent had an older sibling, urban/rural status of the community in which the responding parent lived at age 14, and whether the respondent lived with a grandparent prior to age 3. We considered results from the fully adjusted models as our primary results but present results from unadjusted and minimally adjusted models to show how point estimates and variance change when additional control variables are added. Correlations between independent variables are shown in Figure S3.

Analysis

Missing data were multiply imputed (Appendix "Multiple Imputation," Table S2). We used longitudinal targeted maximum likelihood estimation (LTMLE) for survival analysis in the ltmle R package (version 1.3-0).[49] LTMLE is a doubly robust substitution estimator that incorporates inverse probability weighting and outcome regression modeling and integrates machine learning via SuperLearner to reduce model misspecification (we included SuperLearner libraries SL.earth, SL.glm, SL.glm.interaction, and SL.gam).[50,51]

Using 2 separate models, we estimated average treatment effects (ATEs) for Head Start vs other childcare (reference group) and Head Start vs solely parental childcare (reference group) with risk ratios (RRs) and risk differences (RDs). Under the potential outcomes framework, the ATE(x) equals the ratio or difference of $E\{Y(1)\}$ and $E\{Y(0)\}$, where x is the exposure, Y is the outcome, and $E\{Y(1)\}$ and $E\{Y(0)\}$ are the average potential outcomes "setting" (ie, hypothetically intervening on) exposure and censoring such that everyone attended Head Start (x = 1) and remained uncensored vs everyone attended other childcare or solely parental childcare (x = 0) and remained uncensored.[52,53]

For modification analyses by race, ethnicity, and sex, we fit stratified models, as hypothetical intervention on such social identities (ie, setting them to counterfactual values) is conceptually unclear if not inappropriate.[54] Stratification can illuminate heterogenous effects by social identities without imposing unrealistic assumptions and allows flexibility in model fit.[55]

Table 1. Descriptive characteristics of respondents whose responding parent had a high school degree or less: National Longitudinal Survey of Youth 1997.

	Head Start (*n* = 1120), *n* (%)	Solely parental childcare (*n* = 1943), *n* (%)	Other childcare (*n* = 1141), *n* (%)	Total (*n* = 4281), *n* (%)
Sex				
Male	569 (51)	1022 (53)	575 (50)	2209 (52)
Female	551 (49)	921 (47)	566 (50)	2072 (48)
Race				
American Indian, Eskimo, or Aleut	10 (0.9)	8 (0.4)	9 (0.8)	29 (0.7)
Asian or Pacific Islander	1 (<0.1)	17 (0.9)	6 (0.5)	24 (0.6)
Black or African American	649 (58)	430 (22)	255 (22)	1367 (32)
Other race[a]	141 (13)	299 (15)	94 (8.2)	540 (13)
White	318 (28)	1165 (60)	774 (68)	2292 (54)
Ethnicity				
Not Hispanic	852 (76)	1428 (73)	947 (83)	3293 (77)
Hispanic	267 (24)	514 (26)	194 (17)	986 (23)
Responding parent's highest educational attainment				
High school degree	581 (52)	1170 (60)	850 (74)	2648 (62)
Less than high school degree	539 (48)	773 (40)	291 (26)	1633 (38)
Non-responding parent's highest educational attainment				
High school degree	406 (36)	738 (38)	520 (46)	1703 (40)
Less than high school degree	370 (33)	543 (28)	206 (18)	1134 (26)
More than high school degree	110 (9.8)	367 (19)	267 (23)	751 (18)
Respondent's grandparents' highest educational attainment				
High school degree	357 (32)	732 (38)	504 (44)	1617 (38)
Less than high school degree	518 (46)	708 (36)	294 (26)	1545 (36)
More than high school degree	141 (13)	373 (19)	284 (25)	811 (19)
Responding parent ever received government aid				
No	200 (18)	882 (45)	566 (50)	1673 (39)
Yes	919 (82)	1056 (54)	574 (50)	2600 (61)
Biological mother's age at respondent's birth, median (1st, 3rd quartile), y	23 (20, 27)	24 (21, 28)	24 (21, 28)	24 (20, 28)
Spent 20+ hours in childcare (ages 0–2 y)				
No	769 (69)	1808 (93)	278 (24)	2866 (67)
Yes	347 (31)	135 (6.9)	863 (76)	1349 (32)
Disability (ages 0–2 y)				
No	1032 (92)	1821 (94)	1044 (91)	3942 (92)
Yes	88 (7.9)	121 (6.2)	97 (8.5)	309 (7.2)
Lived with grandparent (ages 0–2 y)				
No	914 (82)	1743 (90)	991 (87)	3722 (87)
Yes	203 (18)	199 (10)	148 (13)	553 (13)
Parent married (ages 0–2 y)				
No	825 (74)	1043 (54)	663 (58)	2573 (60)
Yes	255 (23)	847 (44)	458 (40)	1584 (37)
Average hours/week parents worked (ages 0–2 y), median (1st, 3rd quartile)	20 (2, 21)	20 (15, 25)	27 (20, 40)	20 (14, 32)
Where responding parent lived when they were age 14 y				
Central city	298 (27)	479 (25)	247 (22)	1042 (24)
Suburb	77 (6.9)	218 (11)	158 (14)	464 (11)
Small city or town	475 (42)	775 (40)	443 (39)	1723 (40)
Rural area[b]	270 (24)	470 (24)	293 (26)	1051 (25)
Older sibling				
No	507 (45)	823 (42)	527 (46)	1880 (44)
Yes	494 (44)	955 (49)	436 (38)	1920 (45)
Year of birth				
1980	224 (20)	389 (20)	209 (18)	834 (19)
1981	236 (21)	412 (21)	233 (20)	893 (21)
1982	211 (19)	376 (19)	233 (20)	843 (20)
1983	223 (20)	383 (20)	239 (21)	859 (20)
1984	226 (20)	383 (20)	227 (20)	852 (20)
Years attended Head Start (ages 3–5 y)				
0	0 (0)	1943 (100)	1141 (100)	3092 (72)
1	734 (66)	0 (0)	0 (0)	734 (17)
2	273 (24)	0 (0)	0 (0)	273 (6.4)
3	113 (10)	0 (0)	0 (0)	113 (2.6)
Years attended other childcare (ages 3–5 y)				
0	810 (72)	1943 (100)	0 (0)	2753 (64)
1	173 (15)	0 (0)	182 (16)	355 (8.3)
2	132 (12)	0 (0)	180 (16)	312 (7.3)
3	0 (0)	0 (0)	779 (68)	779 (18)

(continued)

Table 1. Continued

	Head Start (*n* = 1120), *n* (%)	Solely parental childcare (*n* = 1943), *n* (%)	Other childcare (*n* = 1141), *n* (%)	Total (*n* = 4281), *n* (%)
Years solely parental childcare (ages 3–5 y)				
0	335 (30)	0 (0)	779 (68)	114 (26)
1	265 (24)	0 (0)	180 (16)	445 (10)
2	515 (46)	0 (0)	182 (16)	697 (16)
3	0 (0)	1943 (100)	0 (0)	1943 (45)
Ever carried a handgun (ages 12–31 y)[c]	319 (28)	552 (28)	350 (31)	1254 (29)
Ever in serious fight (ages 12–24 y)[d]	454 (41)	634 (33)	403 (35)	1524 (36)
Ever charged with assault (ages 12–41 y)[e]	158 (14)	173 (8.9)	83 (7.3)	425 (9.9)

Row and columns may not sum to total due to missing values.
[a]Not further specified in the National Longitudinal Survey of Youth 1997 (NLSY97).
[b]Includes Indian Reservation and military base.
[c]Of 85 620 total person-years individuals could contribute from ages 12–31 y, we observed 77 873 (91%), with the rest censored due to death or missing 4+ interviews.
[d]Of 55 653 total person-years individuals could contribute from ages 12–24 y, we observed 53 580 (96%), with the rest censored due to death or missing 4+ interviews.
[e]Of 128 430 total person-years individuals could contribute from ages 12–41 y, we observed 109 574 (85%), with the rest censored due to death or missing 4+ interviews.

We grouped follow-up time into approximately 5-year intervals to reduce sparsity. Respondents were censored when they were deceased or missed 4 or more interviews, per NLSY97. We used the LTMLE package's robust variance estimation and so did not cluster standard errors (robust variance estimation is not currently available with clustering).[56] We did not incorporate survey weights as they were not designed for subpopulations we analyzed. We did not report results if based on 10 or fewer outcome events per exposure level or estimates were highly uncertain—for example, if the confidence limit ratio (ratio of upper bound to lower bound) was 30 or higher.

Analyses were conducted in R version 4.1.1 (R Foundation for Statistical Computing, Vienna, Austria). The NLSY97 was approved by the Institutional Review Boards (IRBs) at the Ohio State University and National Opinion Research Center at the University of Chicago.[57] This study was considered not human subjects research by the University of Washington IRB since the data were de-identified.

Sensitivity analyses
As alternative ways of approximating childhood poverty (which was not directly measured in NLSY97), we limited to respondents whose parent (1) had a high school degree or less and were unmarried when respondents were aged 0–2 (as single, less educated mothers are disproportionately likely to be in poverty) (*n* = 2573)[58] and (2) reported ever receiving government aid (another indicator of poverty and eligibility criterion for Head Start)—namely, Aid to Families with Dependent Children, Medicaid, Supplemental Security Income, or food aid (*n* = 3852). In further sensitivity analyses, we incorporated survey weights and conducted a probabilistic quantitative bias analysis (QBA) for unmeasured confounding by childhood poverty (Appendix "Quantitative Bias Analysis").

Results
Study population
Of 4281 respondents in our primary analytic sample whose parent had a high school degree or less, 1943 had solely parental childcare (45.4%), 1141 attended other childcare (26.7%),

and 1120 attended Head Start (26.2%) during ages 3–5 years (Table 1). Approximately half were male and White. Descriptive statistics by intersections of respondent sex, race, and ethnicity are provided in Tables S3–S5. Cumulative incidence of each outcome by exposure (Figure S4) and respondent sex, race, and ethnicity (Figures S5–S7) are depicted graphically.

Handgun carrying
In fully adjusted models, handgun-carrying risk was 0.82 times lower comparing Head Start vs other childcare (95% CI: 0.68, 0.98; Figure 1A) (RD = −0.06; 95% CI: −0.12, −0.006; Figure S8A), with results driven by Black males (RR = 0.77; 95% CI: 0.60, 0.99, Figure 2A; RD = −0.13; 95% CI: −0.27, 0.003; Figure S9A).

Serious fighting
Comparing Head Start with other childcare, serious fighting risk was 0.79 times lower among Black males (95% CI: 0.64, 0.98; Figure 2; RD = −0.13; 95% CI: −0.26, −0.01; Figure 2B), but 1.69 times higher among White females (95% CI: 1.10, 2.61; Figure 2B).
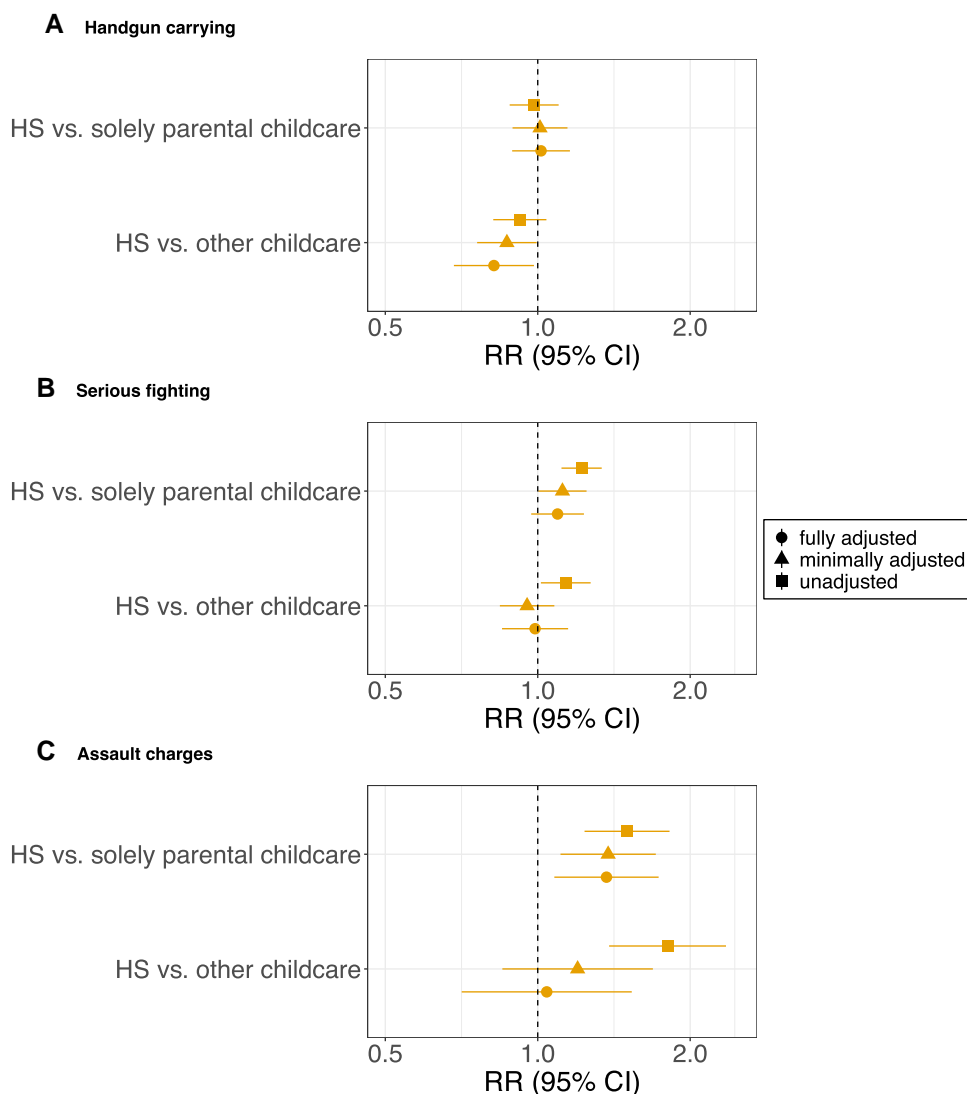
Assault charges
Comparing Head Start vs solely parental childcare, risk of assault charges was 1.37 times higher among all respondents (95% CI: 1.08, 1.73; Figure 1C; RD = 0.04; 95% CI: 0.01, 0.07; Figure S8C), with results driven by White males (RR = 1.64; 95% CI: 1.04, 2.59; Figure 2C).

Sensitivity analyses
When using alternative approximations of poverty, Head Start vs other childcare was consistently associated with a lower risk of handgun carrying and serious fighting among Black males, and most positive associations for serious fighting and assault charges became null (Figures S10 and S11). However, unlike the primary analysis, handgun-carrying risk was greater comparing Head Start with solely parental childcare among White females whose parent was unmarried and had a high school degree or less (Figure S11A), and serious fighting risk

A Handgun carrying

B Serious fighting

● fully adjusted
▲ minimally adjusted
■ unadjusted

C Assault charges

Figure 1. Association of Head Start (HS) and handgun carrying (A), serious fighting (B), and assault charges (C) among respondents whose parent had a high school degree or less. Risk ratios (RRs) are plotted on the log scale. Results based on imputed data. Minimally adjusted models controlled for race (Black, other race, White), ethnicity (Hispanic, not Hispanic), sex (male, female), grandparents' highest educational attainment (less than high school degree, high school degree, more than high school degree), responding parent's highest educational attainment (less than high school degree, high school degree), non-responding parent's highest educational attainment (less than high school degree, high school degree, more than high school degree), weighted average number of hours responding parent and parent's partner worked when respondent was 0–2 years old (continuous), number of sources of government aid the responding parent ever received (none, 1, 2+), responding parent's marital status when respondent was 0–2 years old, and interactions of race and sex, ethnicity and sex, and responding parent's educational attainment and marital status. Fully adjusted models controlled for covariates in minimally adjusted models, plus any childcare when respondent was 0–2 years (binary), respondent disability from age 0–2 years (binary), respondent's birth year (continuous), age of respondent's biological mother when respondent was born (continuous), whether respondent had an older sibling (binary), where responding parent lived when they were 14 years old (central city, suburb, small city or town, rural), and whether respondent ever lived with their grandparent from age 0–2 years (binary).

was greater comparing Head Start with solely parental child-care among White females whose parent ever received government aid (Figure S11B). When applying NLSY97 survey weights, results were largely consistent with the main analysis (Figures S12 and S13).

Results of the QBA (see Table S6 for bias parameters) suggest that estimates from the main analyses were biased upwards (Figures S14 and S15). When restricting the population to those simulated to be in poverty during early childhood, there was no evidence that Head Start was associated with increased risk of any outcome (for any subpopulation), and protective associations of Head Start vs other childcare among Black males became stronger (handgun

carrying RR = 0.63; 95% CI: 0.46, 0.94; serious fighting RR = 0.70; 95% CI: 0.53, 1.00).

Discussion

Results of this national study suggest that attending Head Start vs other childcare during ages 3–5 years reduced Black males' risk of handgun carrying (by age 31) and serious fighting (by age 24) by approximately 23% and 21%, respectively. Findings for other intersectional groups were null or sensitive to how we approximated childhood poverty, but there was suggestive evidence of increased serious fighting risk comparing Head Start with other childcare for White females (which
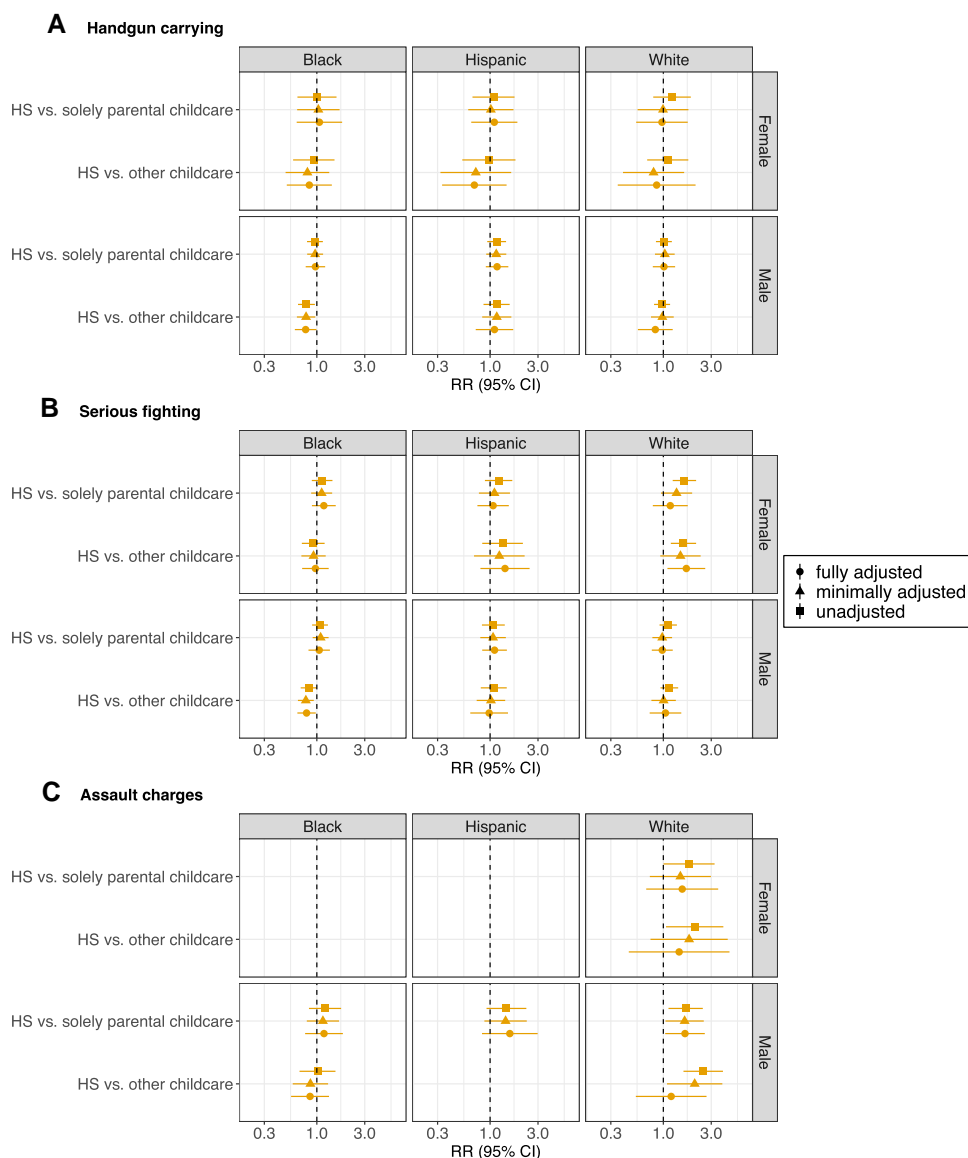
Figure 2. Association of Head Start (HS) and handgun carrying (A), serious fighting (B), and assault charges (C) by intersections of race, ethnicity, and sex among respondents whose parent had a high school degree or less. Risk ratios (RRs) are plotted on the log scale. Results based on imputed data. Minimally adjusted models controlled for grandparents' highest educational attainment (less than high school degree, high school degree, more than high school degree), responding parent's highest educational attainment (less than high school degree, high school degree), non-responding parent's highest educational attainment (less than high school degree, high school degree, more than high school degree), weighted average number of hours responding parent and parent's partner worked when respondent was 0–2 years old (continuous), number of sources of government aid the responding parent ever received (none, 1, 2+), responding parent's marital status when respondent was age 0–2 years, and interactions of responding parent educational attainment and marital status. Fully adjusted models controlled for covariates in minimally adjusted models, plus any childcare when respondent was 0–2 years old (binary), respondent disability from age 0–2 years (binary), respondent's birth year (continuous), age of respondent's biological mother when respondent was born (continuous), whether respondent had an older sibling (binary), where responding parent lived when they were 14 years old (central city, suburb, small city or town, rural), and whether respondent ever lived with their grandparent from age 0–2 years (binary). Models stratified by race were adjusted for ethnicity (Hispanic, not Hispanic), and models stratified by ethnicity were adjusted for race (Black, other race, White). Results are not reported if based on 10 or fewer outcome events per exposure level or if the confidence limit ratio (ratio of upper bound to lower bound) was 30 or higher.

disappeared in our QBA accounting for unmeasured childhood poverty).

Our results are consistent with prior research showing particularly large benefits of high-quality early childhood education programs for those with the highest levels of disadvantage or risk to begin with (eg, for outcomes including educational attainment, substance use, and crime in general).[25,30,33-37] These heterogenous treatment effects suggest that Head Start reduces racialized disparities,[59] likely amplifying the equity-focused design of the policy itself—which serves low-income children and families. Given that

Black males are disproportionately affected by interpersonal (especially firearm) violence in the United States, and that many public health and policy interventions benefit those who are best off,[60] our results suggesting disproportionate benefits of Head Start for Black males are notable and have important implications for promoting equity.

That protective associations of Head Start were observed when compared with other childcare aligns with prior research on the importance of early learning environment quality and parental support and has programmatic and policy implications for early childhood education. Specifically, prior

work suggests that the most important feature of early childhood care and learning environments is quality (eg, positive, interactive, and sensitive caregiving, such as that provided by Head Start),[61,62] and that Head Start might impart particularly large benefits when compared with other preschool (which, for disadvantage families, may be of relatively low quality).[30,34,63,64] This indicates a need to expand access to high-quality early childhood education, as few parents can afford to be the sole care provider for their children, and many families, especially those belonging to structurally marginalized groups, continue to face barriers in accessing affordable, high-quality early childhood education.[65,66] Expanded access would also support parents' (particularly mothers') labor force participation.[67] In addition to providing time for parents to work, Head Start is unique in that it explicitly supports positive parenting and parents' educational and employment goals, with research suggesting that these efforts are effective.[68] This parental focus may help explain the particular benefits of Head Start relative to other childcare observed in our study.

Our findings also align with prior research on the salience of the comparison group/counterfactual care environments for interpreting results.[61] For example, due partly to racial residential segregation, White children (regardless of income) tend to have access to higher-quality early care and learning environments than children of color.[69,70] This (with gender differences in development and socialization[71]) could help explain why White females were the only group to experience lower risk of serious fighting if they attended other (non-Head Start) childcare vs if they attended Head Start (that is, the other childcare they received may have been of even higher quality than Head Start). This finding could also reflect residual confounding at the individual or family level, since children may be selected into Head Start because they are at higher risk for poor outcomes (thus, without proper adjustment, Head Start could appear harmful); this aligns with the results of our QBA for unmeasured poverty. Furthermore, while we hypothesized that Head Start would reduce violence and handgun carrying compared with solely parental care, we found no association. This could be because parents who chose/were able to care for their children entirely at home had the ability to provide similarly nurturing, warm, and stimulating environments (conditional on income/poverty) as that provided by Head Start.[72,73] Similarly, if low-income children with additional risk factors (eg, family violence, substance use) were more likely than other low-income children to attend Head Start vs solely parental childcare, our findings would suggest that Head Start equalized outcomes for children who would have otherwise had higher risk.

Limitations

Sample size combined with relatively rare outcomes resulted in some imprecise estimates. This may explain why Head Start–associated reductions in handgun carrying and serious fighting for Black males did not translate into reduced risk of assault charges. We used proxy variables to identify the population in poverty and thus eligible for Head Start (because early childhood poverty was not measured in NLSY97); each proxy is imperfect, but it is notable that findings were largely consistent across numerous sensitivity analyses. Estimates may be subject to unmeasured confounding, and our QBA suggested that unmeasured childhood poverty status biased our estimates upward. That differences in indicators of socioeconomic disadvantage across exposure (Head Start, solely parental care, and other childcare) were less pronounced for Black respondents than for Hispanic and White respondents aligns with prior research[34] and suggests that the pervasiveness of racism limited confounding in analyses of Black respondents. Parental educational attainment was measured at the first survey wave so may not reflect educational attainment when respondents were age 0–2 years. However, prior research suggests that, while Head Start increases parental educational attainment, it is generally not associated with changes in degree attainment (moving from a high school degree to college).[45] Likewise, parents were asked, at the first survey wave, if they ever received government aid from the time they turned 18/their eldest child was born through the present. If they first received government aid after their child attended Head Start, the temporal order vis-à-vis Head Start exposure may therefore be incorrect. Not all children attended Head Start and other childcare for all 3 years from ages 3–5 (eg, in our sample, 66% of Head Start attendees attended Head Start for 1 year and 24% attended for 2 years), suggesting that our estimates were attenuated towards the null (sample size constraints precluded us from examining "dose" of Head Start). We also lacked specific information on the experiences of children in comparison groups. Finally, there is potential for recall and social desirability biases.

Conclusion

Findings suggest that high-quality early childhood education programs may reduce later-life handgun carrying and serious fighting among those at highest risk. Early-life investments in the social, economic, and human capital of structurally disadvantaged children and families may be effective and antiracist tools to prevent violence and firearm-related harms.

Supplementary material

Supplementary material is available at *Health Affairs Scholar* online.

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Conflicts of interest

Please see ICMJE form(s) for author conflicts of interest. These have been provided as supplementary materials.

Data availability

This research was conducted with publicly available Bureau of Labor Statistics (BLS) data. The views expressed here are those of the author and do not reflect the views of the BLS.

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