

Firearm Homicide and Other Causes of Death in Delinquents: A 16-Year Prospective Study

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KEY WORDS

alcohol use, drug dealing, gangs, firearms, juvenile delinquents, longitudinal studies, mortality, prospective studies, public health, substance use

ABBREVIATIONS

aHR—adjusted hazard ratio
CCJTDC—Cook County Juvenile Temporary Detention Center
CI—confidence interval
DISC-2.3—Diagnostic Interview Schedule for Children, Version 2.3
DIS-IV—Diagnostic Interview Schedule, Version IV
JK—Jackknife technique method

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(Continued on last page)



WHAT'S KNOWN ON THIS SUBJECT: Homicide is the third leading cause of mortality in general population youth aged 15 to 29 years. Groups at greatest risk for early violent death (racial/ethnic minorities, males, poor persons, and urban youth) are overrepresented in the juvenile justice system.



WHAT THIS STUDY ADDS: We examined rates of and risk factors for firearm homicide and other causes of death in delinquents 16 years after detention. Our study analyzes gender differences; compares Hispanics, African Americans, and non-Hispanic whites; and includes a representative sample of delinquents.

abstract



BACKGROUND: Delinquent youth are at risk for early violent death after release from detention. However, few studies have examined risk factors for mortality. Previous investigations studied only serious offenders (a fraction of the juvenile justice population) and provided little data on females.

METHODS: The Northwestern Juvenile Project is a prospective longitudinal study of health needs and outcomes of a stratified random sample of 1829 youth (657 females, 1172 males; 524 Hispanic, 1005 African American, 296 non-Hispanic white, 4 other race/ethnicity) detained between 1995 and 1998. Data on risk factors were drawn from interviews; death records were obtained up to 16 years after detention. We compared all-cause mortality rates and causes of death with those of the general population. Survival analyses were used to examine risk factors for mortality after youth leave detention.

RESULTS: Delinquent youth have higher mortality rates than the general population to age 29 years ($P < .05$), irrespective of gender or race/ethnicity. Females died at nearly 5 times the general population rate ($P < .05$); Hispanic males and females died at 5 and 9 times the general population rates, respectively ($P < .05$). Compared with the general population, significantly more delinquent youth died of homicide and its subcategory, homicide by firearm ($P < .05$). Among delinquent youth, racial/ethnic minorities were at increased risk of homicide compared with non-Hispanic whites ($P < .05$). Significant risk factors for external-cause mortality and homicide included drug dealing (up to 9 years later), alcohol use disorder, and gang membership (up to a decade later).

CONCLUSIONS: Delinquent youth are an identifiable target population to reduce disparities in early violent death. *Pediatrics* 2014;134:63–73

Delinquency is commonly associated with the perpetration of violence, but delinquent youth are also at risk for early violent death.^{1–5} In their classic study of 500 white delinquent male subjects sampled in the 1940s,² Glueck and Glueck found that nearly 5% had died by age 32 years, compared with 2.2% of nondelinquent control subjects. Increased risk persisted to age 65 years.³ A more recent longitudinal study of delinquent youth found that their mortality rates, after adjusting for demographic differences, were >4 times those of general population youth.⁴

Few longitudinal studies of delinquent youth have examined risk factors for early violent death. Some studies had too few deaths to analyze risk factors.^{1,5} The largest and most recent investigations found substance abuse, gang involvement, and criminal activity are among the risk factors associated with early violent death.^{6,7,8}

These previous investigations provide important data, but they have limitations:

1. The samples do not reflect the demographic characteristics of today's delinquent youth. There are few data on females,^{3,6} who now comprise nearly 30% of arrested youth¹⁰ and have mortality rates up to 8 times those of the general population.⁴ One study³ did not include racial/ethnic minorities, groups who are disproportionately incarcerated. African Americans and Hispanics now comprise one-third of the general population aged 15 to 29 years¹¹ but approximately two-thirds of incarcerated youth¹² and young adults.¹³ More than one-third of low-income African-American children have been arrested by age 24 years, and >20% have been incarcerated.¹⁴
2. Previous studies examined only serious offenders who had been convicted and had served time in correctional facilities.^{3,6,7} These studies have limited generalizability because serious offenders constitute only

a fraction of the 1.5 million cases processed in juvenile court each year.¹⁵

3. Many studies did not calculate mortality rates (deaths per person-years)^{1,3,5,9} or compare rates with the general population according to gender, race/ethnicity, and age.^{6,7}

We addressed these limitations by using newly available data from the Northwestern Juvenile Project, a large-scale longitudinal study of health needs and outcomes of delinquent youth.^{4,16,17} We used interview data and obtained official death records up to 16 years after participants' baseline interview, analyzing all-cause mortality and deaths from all external causes (homicides, unintentional injuries, and suicides),¹⁸ homicide alone, and firearm homicide alone. In the present article, we: (1) calculated mortality rates according to gender, race/ethnicity, and age, comparing them with the general population in Cook County, Illinois (hereafter referred to as general population); (2) compared causes of death with the general population; and (3) determined the association between mortality and modifiable risk factors, such as substance use disorders, gang membership, and drug dealing.

METHODS

Delinquent Sample

Baseline Interview

We recruited a stratified random sample of 1829 youth at intake to the Cook County Juvenile Temporary Detention Center (CCJTDC) in Chicago, Illinois, between November 20, 1995, and June 14, 1998, who were awaiting the disposition of their case. To ensure adequate representation of key subgroups, we stratified our sample according to gender, race/ethnicity (African American, non-Hispanic white, Hispanic, and other), age (10–13 years or ≥14 years), and legal status (processed in juvenile or adult court). Youth were eligible to participate in the

study regardless of the severity of their alleged offense. Project staff interviewed participants (most within 2 days of intake) at the detention center in a private area.

Follow-up Interview

Analyses also include data from the first follow-up interview ~3 years after detention. We interviewed participants regardless of where they were living. The participation rate was 90.7% (1659 of 1829). There were no significant demographic differences in retention.

Procedures to Obtain Assent and Consent

Participants signed either an assent form (if they were aged <18 years) or a consent form (if they were aged ≥18 years). The institutional review boards of Northwestern University and the Centers for Disease Control and Prevention waived parental consent, consistent with federal regulations regarding research with minimal risk.¹⁹ We nevertheless tried to contact parents to provide them information and used an independent participant advocate to represent the interests of the participant.

Variables and Measures

Deaths: Participants' deaths, from November 1995 to December 2011, were tracked and verified by using death certificates.

Risk Factors: Substance use disorders were assessed by using age-appropriate measures at baseline (Diagnostic Interview Schedule for Children, version 2.3 [DISC-2.3])^{20,21} and again at the follow-up interview (Diagnostic Interview Schedule, version IV [DIS-IV]).^{22,23} Previous use of drugs other than marijuana (sometimes known as "hard drugs" [eg, cocaine, heroin, hallucinogens]) was assessed at baseline (by using questions from the DISC-2.3). Drug dealing, gang membership, and firearm use were added at the follow-up interview

(by using questions from the Denver Youth Survey).^{24,25}

General Population Data

The comparison groups included African Americans, non-Hispanic whites, and Hispanics in the general population of Cook County, Illinois, who were aged 15 to 29 years. Death counts were obtained from vital records in 2000, 2005, and 2008 (the most recent data available).²⁶ Population counts for 5-year age groups were obtained from mid-year census estimates for these same years.²⁷ Additional information on our methods is provided in the Supplemental Appendix and published elsewhere.^{4,16,17}

Statistical Analysis

Comparison of Our Sample With the General Population

We compared standardized all-cause mortality rates and specific causes of death between our study sample and the Cook County, Illinois, general population. We estimated mortality rates in our sample by calculating the deaths per 100 000 person-years lived during the intervals 15 to 19, 20 to 24, and 25 to 29 years of age. Because selected strata were oversampled (Supplemental Appendix), we used sampling weights to estimate mortality rates that reflect CCJTDC's population; 95% confidence intervals (CIs) were estimated by using the jackknife method.

We estimated all-cause mortality rates in Cook County by using the single-decrement period life table method.²⁸ To make contemporaneous comparisons between our cohort data and period data from Cook County, we created 3 synthetic cohorts from the years 2000, 2005, and 2008. We standardized Cook County rates to reflect the racial/ethnic and gender distribution of the CCJTDC population; 95% CIs were based on the Poisson distribution.²⁹ We used the delta method to

compute rate ratios comparing mortality rates and specific causes of death.

Risk Factors for Mortality in Delinquent Youth After Detention

We estimated the relationship between risk factors and subsequent external-cause mortality, homicide, and firearm homicide by using weighted nonparametric survival analyses. Kaplan-Meier functions were used to compare the probability of survival according to race/ethnicity (self-reported), gender, and presence of risk factors.³⁰ Substance use disorders were analyzed at the baseline interview and at the follow-up interview (to be contemporaneous with analyses of other risk factors).

Weighted Cox proportional hazards regression was used to estimate unadjusted hazard ratios for each risk factor and hazard ratios adjusted for demographic characteristics (gender, race/ethnicity, and age at baseline).³⁰ For risk factors that violated the proportional hazards assumption, we included time-dependent covariates in our models (time squared for gang membership and drug dealing; time for alcohol use disorder). For risk factors measured at follow-up interviews, we augmented sampling weights with a nonresponse adjustment to account for missing data.³¹ Taylor series linearization was used to estimate SEs.^{32,33} When analyzing specific causes of death, other deaths were treated as censored. Because incarceration restricts some exposures associated with external-cause mortality (eg, firearm-related injuries, automobile crashes),³⁴ and because no participant died while incarcerated, we excluded days when participants were incarcerated from the exposure time in all survival analyses. Days incarcerated were drawn from official records. The median exposure time from baseline through December 2011 was 14.7 years (mean [SE]: 13.6 [0.1] years; range, 0.4–16.1 years). The median

exposure time from the follow-up interview through December 2011 was 11.5 years (mean [SE]: 10.9 [0.1] years; range, 0.2–13.1 years).

Analyses were conducted by using Stata version 12 software (Stata Corp, College Station, TX) and its survey routines.³⁵ In the following discussions, we address only statistically significant findings ($P < .05$).

RESULTS

Of the 1829 original participants, 111 died: 7% of males and nearly 4% of females. Among those who died, 75 (68%) were homicides. Of these, 68 (91%) participants were killed with firearms (Table 1).

Comparison of Our Sample With the General Population

Mortality Rates

Figure 1 compares standardized mortality rates between our sample and the general population according to gender, race/ethnicity, and age by using Cook County, Illinois, data from 2005. (We also compared mortality rates using data from 2000 and 2008. The results were similar and are available from the authors.) In nearly every demographic subgroup, delinquent youth had significantly higher mortality rates than the general population. For example, the mortality rates of Hispanic males were 4.9 times the general population rates; mortality rates of Hispanic females were >9 times the general population rates. African-American males had the highest mortality rate in our sample, but their standardized mortality ratio (2.7 times the general population rate) was lower than most other demographic subgroups. In contrast, non-Hispanic white males had a lower mortality rate than minority males, but their standardized mortality ratio was 4.4 times the general population rate.

Although most mortality rates decreased with age, delinquent youth remained at

TABLE 1 Number of Deaths in Delinquent Youth ($N = 1829$) 16 Years After Juvenile Detention, According to Cause of Death

Variable	All Cause	External Cause	Homicide	Homicide by Firearm
All ($N = 1829$)	111	105	75	68
Male ($n = 1172$)	86	85	65	61
Race/ethnicity				
African American ($n = 575$)	42	41	37	36
Non-Hispanic white ($n = 207$)	14	14	6	4
Hispanic ($n = 387$)	30	30	22	21
Other ($n = 3$)	0	0	0	0
Female ($n = 657$)	25	20	10	7
Race/ethnicity				
African American ($n = 430$)	17	12	8	5
Non-Hispanic white ($n = 89$)	2	2	0	0
Hispanic ($n = 137$)	6	6	2	2
Other ($n = 1$)	0	0	0	0
Age at death, y				
15–19	40	40	30	30
20–24	37	35	23	20
25–29	30	27	19	15
30–34	4	3	3	3

Causes of death are not mutually exclusive.

increased risk in adulthood. Mortality rates of males aged 15 to 19 years were 5 times those of the general population. At ages 25 to 29 years, male mortality rates were still more than twice the general population rates. Differences according to age were even greater among females: those aged 15 to 19 years had mortality rates 9 times the general population rates, and those aged 25 to 29 years were 3.5 times the general population rates.

Cause of Death

Figure 2 compares causes of death between our sample and the general population according to gender (percentages are weighted to reflect the demographic characteristics of detained youth). Homicide (90% of deaths among delinquent males, 42% among delinquent females) and its subcategory, homicide by firearm (86% of deaths among delinquent males, 28% among delinquent females), account for a significantly greater proportion of deaths in the delinquent population than in the general population (for males, homicide ratio: 2.3 [95% CI: 2.1–2.6]; firearm homicide ratio: 2.5 [95% CI: 2.1–2.9]; for females, homicide ratio: 3.0 [95% CI: 1.7–5.2]; firearm homicide ratio: 4.0 [95% CI: 1.8–8.9]).

Risk Factors for Mortality in Delinquent Youth After Detention

Figure 3 presents Kaplan-Meier survival curves on demographic characteristics (gender and race/ethnicity), drug dealing, gang membership, and alcohol use disorder for external-cause mortality and its subcategory, homicide. These curves represent the decline in the probability of survival over time (years since detention) according to demographic characteristic or presence and absence of risk factors. Figure 4 displays the associated adjusted hazard ratio (aHR) estimates over time (years since detention) for gang membership, drug dealing, and alcohol use disorder (analogous figures for homicide by firearm are given in Supplemental Figures 5 and 6). A hazard ratio >1.0 indicates a greater hazard of mortality among those with the risk factor compared with those without the risk factor; <1.0 indicates a lesser hazard of mortality for those with the risk factor; and 1.0 indicates no difference.

Demographic Characteristics

Compared with delinquent females, delinquent males had >4 times the hazard of external-cause mortality and >7 times the hazard of homicide (aHR: 4.4

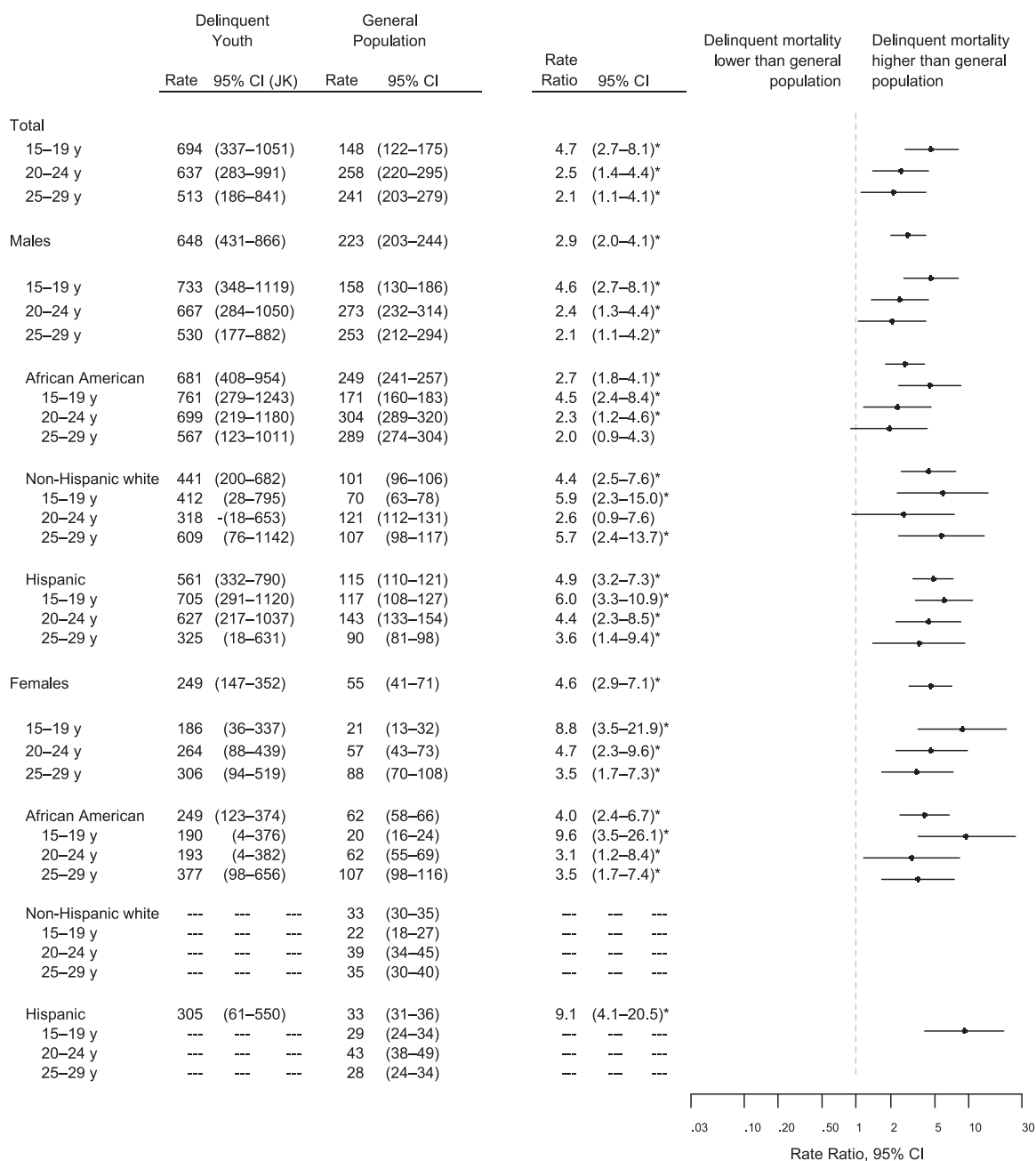
[95% CI: 2.5–7.6]; aHR: 7.3 [95% CI: 3.5–14.9], respectively). Racial/ethnic minorities were at increased risk of homicide: compared with non-Hispanic whites, African Americans had 4.5 times (95% CI: 1.8–11.2) and Hispanics had 2.8 times (95% CI: 1.1–7.2) the hazard of homicide (Supplemental Tables 2 and 3).

Gang Membership and Drug Dealing

Gang membership (78.4% of males; 40.7% of females) and drug dealing (85.8% of males; 48.4% of females) were significantly associated with external-cause mortality and homicide. The hazard of external-cause mortality and homicide decreased over time (Figure 4) but was still significant 10 years after detention for gang membership and 9 years after detention for drug dealing. For example, 5 years after detention, gang members had 10.7 times the hazard of homicide compared with those who had not been gang members (95% CI: 2.4–48.5). Nine years after detention, the hazard ratio was 3.4 (95% CI: 1.3–9.1). Delinquent youth who had dealt drugs had 6.5 times the hazard of homicide 5 years after detention (95% CI: 1.7–25.6) and 3.6 times the hazard 8 years after detention (95% CI: 1.1–12.1) compared with those who had not dealt drugs.

Alcohol Use Disorder

Delinquent youth with an alcohol use disorder at the follow-up interview (19.1% of males; 10.7% of females) had a significantly increased risk of external-cause mortality and its subcategory, homicide, compared with those without the disorder. For example, 5 years after detention, the hazard of homicide was 4.7 times higher for those with alcohol use disorder (95% CI: 1.5–15.4). The strength of this association decreased over time but remained significant 10 years after detention (Figure 4), when persons who had met criteria for an alcohol use disorder still had 3.2 times (95% CI: 1.1–9.5) the hazard of homicide. Additional findings on demographic characteristics, other

**FIGURE 1**

Standardized all-cause mortality rates of delinquent youth after detention ($N = 1829$) compared with the general population. Rates for delinquent youth are given in deaths per 100 000 person-years; rates for the general population are given in deaths per 100 000 person-years in Cook County, 2005. We do not report racial/ethnic or age specific rates for groups with ≤ 3 deaths in our sample. Crude mortality rates across racial/ethnic categories were weighted to reflect the racial/ethnic distribution of the CCJTD. *Indicates a statistically significant difference in mortality rates ($P < .05$).

risk factors, and firearm-related homicide are available in the Supplemental Appendix (Supplemental Tables 2, 3, and 4, Supplemental Figures 5 and 6).

DISCUSSION

To our knowledge, this is the first large-scale study to document the high death

rate of delinquent females in adulthood, providing new data on mortality rates and modifiable risk factors in this vulnerable population. Although risk of mortality is lower in delinquent females than males, delinquent females died at nearly 5 times the rate of females in the general population.

Our study also adds new information on mortality rates among Hispanics, now the largest racial/ethnic minority group in the United States.³⁶ The mortality rate among delinquent Hispanic males was nearly 5 times the general population rate; among Hispanic females, 9 times the general population rate.³⁷

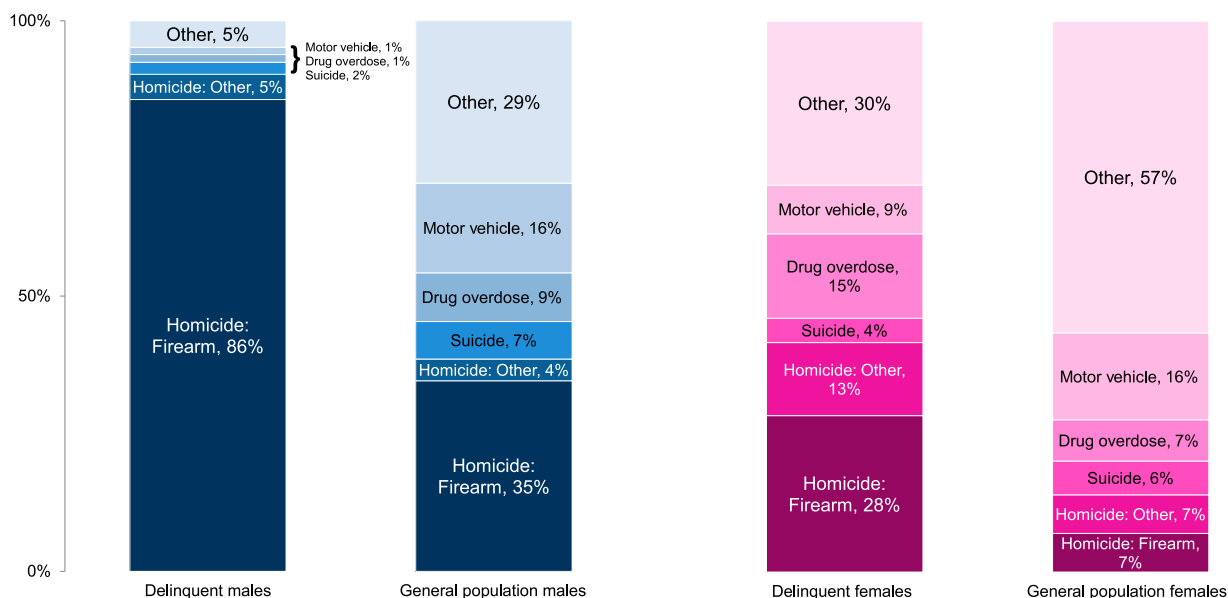


FIGURE 2

Causes of death of delinquent youth at ages 15 to 29 compared with the general population ($N = 1829$), standardized on CCJTDC population. General population refers to all males and females ages 15 to 29 years who died in Cook County, Illinois, in 2005. Other cause of death includes internal causes and other accidents. Compared with the general population, delinquent males and females experienced a significantly ($P < .05$) higher percentage of deaths due to homicide and its subcategory, homicide by firearm. The total proportion of deaths due to homicide (firearm and other) were 90% for delinquent males, 39% for general population males, 42% for delinquent females, and 14% for general population females. Due to rounding error, sums of percentages in the figure may not be accurate.

Mortality rates among delinquent Hispanics were more similar to those of African Americans than to non-Hispanic whites, unlike patterns in the general population, in which Hispanic and non-Hispanic whites have similar rates.^{37,38} Delinquent youth continue to have substantially higher mortality rates than the general population in adulthood, irrespective of gender or race/ethnicity. Homicide was the most prevalent cause of death among male (90%) and female (42%) participants; nearly all homicides involved firearms. African-American males had the highest mortality rates but among the lowest mortality ratios because death rates among African Americans in the general population are high.³⁷ Our findings mirror racial/ethnic disparities in the general population. In 2010, African-American males comprised 14.6% of the general population aged 15 to 29 years¹¹ but nearly 75% of deaths by homicide.³⁷ It is difficult to compare our mortality rates with previous studies of delinquent youth because of the aforementioned

methodologic differences and limitations. The most comparable longitudinal study found zero deaths among female subjects and much lower overall mortality rates.¹ The mortality rates found in our study are most similar to those of adults in jail³⁹ and prison,^{40–43} who have substantially higher mortality rates than the general population.

None of our participants died while incarcerated. This finding highlights the relative safety of correctional institutions because incarceration limits exposure to firearms and automobile crashes.³⁴ Re-entry to the community seems to be a time of particular risk, especially for drug overdose and homicide.^{39–41,43}

Limitations

It was not feasible to study multiple jurisdictions, and our findings may be generalizable only to detained youth in urban centers with similar demographic compositions. The actual mortality ratios may be even greater than those observed because our sample and the general

population are not mutually exclusive; the general population also includes youth who have been detained. Moreover, we may have underestimated mortality ratios for younger males and racial/ethnic minorities because the US Census undercounts these groups.⁴⁴ Because death was relatively uncommon, some 95% CIs were wide. Although retention rates were high, findings on risk factors measured at follow-up may have been affected by missing data.

Implications

Our study provides new evidence that modifiable risk factors (alcohol use disorder, gang membership, and drug dealing) are associated with mortality up to a decade after detention. Early prevention is key.^{45,46} Fortunately, promising innovations are available. For example, the Good Behavior Game, administered to school children ages 5 to 9 years, reduced alcohol abuse, violence, and other problem behaviors in young adulthood (ages 19–21 years).^{47,48}

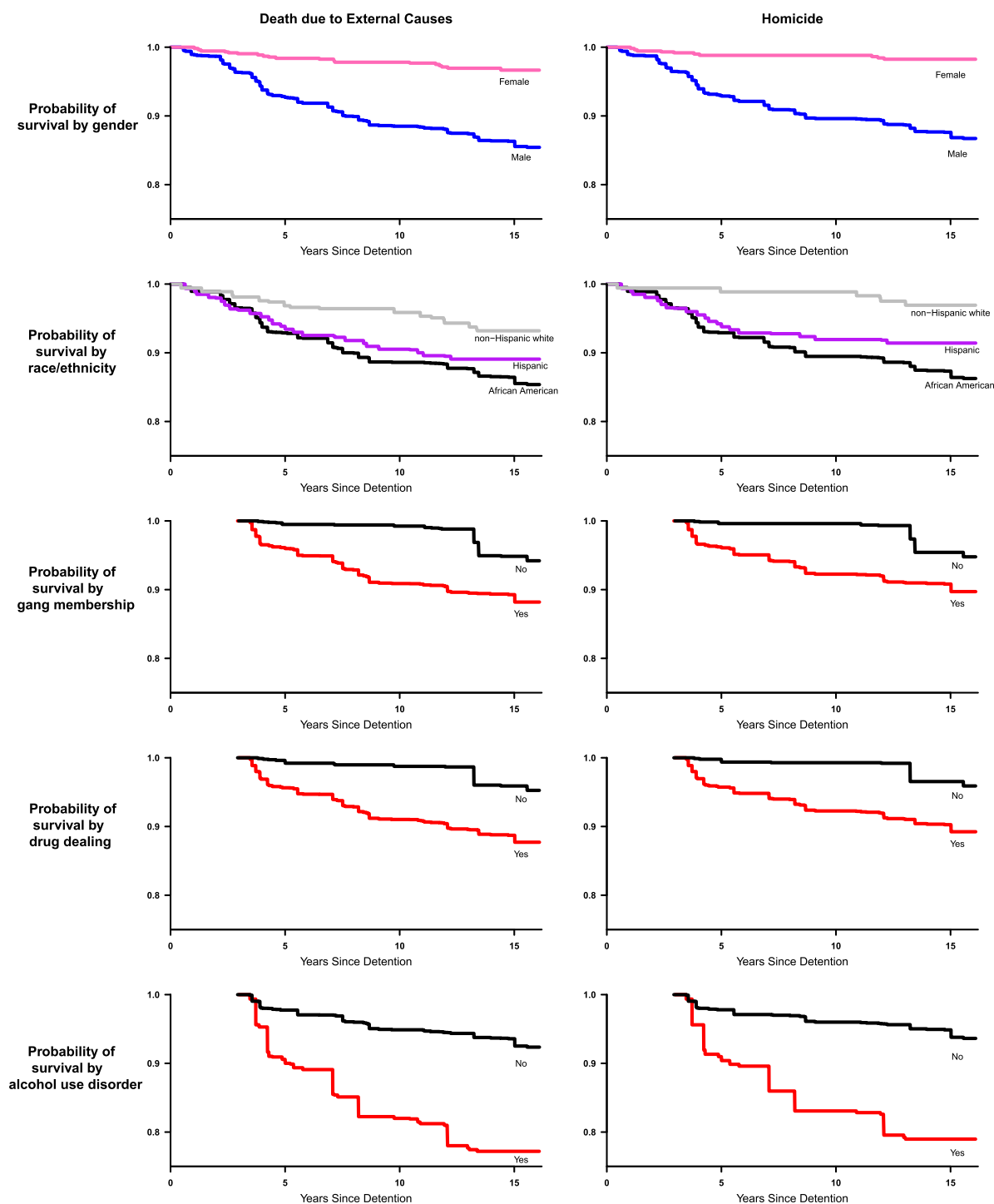


FIGURE 3

Kaplan-Meier estimates of the probability of survival in delinquent youth after detention according to demographic characteristics and risk factors. Estimates for survival by gender and race/ethnicity are estimated for $n = 1798$ participants (of the original 1829 participants, 4 identified as other race/ethnicity, 6 were missing correctional records, and 21 were incarcerated during the entire study period). Estimates for survival by gang membership and drug dealing are estimated for $n = 1619$ participants (of the original 1829 participants, 31 died before the follow-up interview, 5 withdrew from the study, 42 were lost to follow-up, 92 were interviewed past the 4.5-year cutoff, 4 participants identified as other race/ethnicity, 6 were missing correctional records, 19 were incarcerated during the entire study period, and 11 were missing “selling drugs” and “gang membership”). Estimates for survival by alcohol use disorder are estimated for $n = 1615$ participants (of the original 1829 participants, 31 died before the follow-up interview, 5 withdrew from the study, 42 were lost to follow-up, 92 were interviewed past the 4.5-year cutoff, 4 participants identified as other race/ethnicity, 6 were missing correctional records, 19 were incarcerated during the entire study period, and 15 were not assessed for alcohol use disorder).

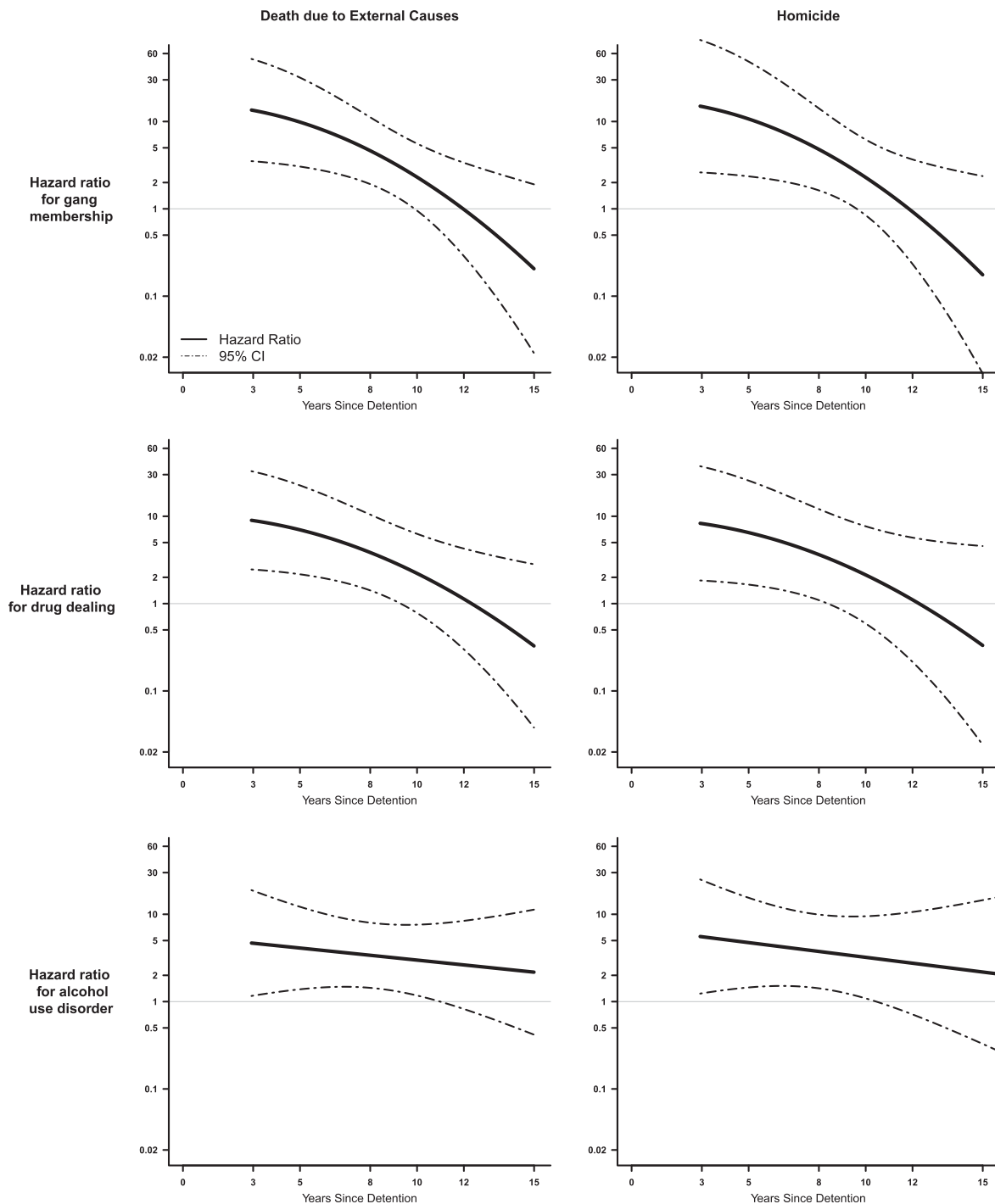


FIGURE 4

Hazard ratio estimates of mortality in delinquent youth after juvenile detention: time-dependent risk factors. Hazard ratio estimates for gang membership and drug dealing are estimated for $n = 1619$ participants (of the original 1829 participants, 31 died before the follow-up interview, 5 withdrew from the study, 42 were lost to follow-up, 92 were interviewed past the 4.5-year cutoff, 4 participants identified as other race/ethnicity, 6 were missing correctional records, 19 were incarcerated during the entire study period, and 11 were missing “selling drugs” and “gang membership”). Hazard ratio estimates for alcohol use disorder are estimated for $n = 1615$ participants (of the original 1829 participants, 31 died before the follow-up interview, 5 withdrew from the study, 42 were lost to follow-up, 92 were interviewed past the 4.5-year cutoff, 4 participants identified as other race/ethnicity, 6 were missing correctional records, 19 were incarcerated during the entire study period, and 15 were not assessed for alcohol use disorder).

As a result of the Patient Protection and Affordable Care Act,⁴⁹ which includes the Prevention and Public Health Fund,

primary care clinicians (pediatricians, nurses, nurse practitioners, and social workers) have new opportunities to

become involved in prevention. First, they are in a unique position to screen for mental health and substance abuse

problems and refer their patients for the most effective interventions. Second, preventive interventions can be integrated into primary care settings.⁵⁰ Incredible Years,⁴⁵ a training program for parents of 2- to 4-year-olds who have disruptive behaviors, demonstrates the feasibility of this approach. Finally, pediatricians are well suited to be leaders in prevention systems such as Communities That Care.^{51,52} Such coalitions guide key stakeholders to choose preventive interventions from a menu of tested programs based on their community's profile for risk. Interventions are available for young children, adolescents, and special populations such as Hispanics and African Americans.⁵⁵ The greater challenge is to provide services for delinquent youth. Although the juvenile justice system provides services in detention centers, courts, and court-mandated programs,⁵⁴ the need for these services greatly exceeds availability.⁵⁵ Moreover, nearly all detained youth eventually return to their communities.⁵⁶ Traditional services may then be inaccessible: delinquent youth may not

have access to health care^{57,58}; may not attend school regularly⁵⁹ and therefore not receive school-based interventions; and may not have a stable caretaker,⁶⁰ a requirement for many interventions.⁵⁴ Comprehensive evidence-based treatments, such as multisystemic therapy⁶¹ and functional family therapy,⁶² address some of these barriers. Effective interventions could reduce the propensity of offenders to become victims.^{63–65}

CONCLUSIONS

Although homicide rates have dropped dramatically since their all-time high in the late 1990s,⁶⁶ 11 101 people were killed in firearm homicides in 2011.⁶⁷ We failed to reach the Surgeon General's goal (from Healthy People 2010) to cut homicide rates in one-half.⁶⁸ Our study of delinquent youth identifies the vulnerability of females, the high risk of mortality among African Americans and Hispanics, and the importance of modifiable risk factors (alcohol use disorder, gang membership, and drug dealing). Moreover, disparities in life

expectancy between African Americans and non-Hispanic whites⁶⁹ may persist, in part, because delinquent African-American youth have higher death rates from homicide. Delinquent youth are an identifiable target population to reduce disparities in early violent death.

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