RESEARCH ARTICLE

Developmental Comorbidity of Substance Use and Handgun Carrying Among U.S. Youth

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Introduction: This study identifies the longitudinal trajectories of multiple forms of substance use and handgun carrying and examines their comorbidity over time.

Methods: In a cohort study of 6,748 youth from a U.S. nationally representative sample (51% male, 49% female; 69% White, 16% Black, 14% Hispanic, and 1% other race/ethnicity; born between 1980 and 1984), individuals self-reported their substance-use status (i.e., smoking, drinking, marijuana use, and hard drug use), handgun carrying, and other covariates between 1997 and 2013. Group-based trajectory modeling was used to identify distinct patterns of substance use and handgun carrying over time. Chi-square tests were used to determine the bivariate associations between substance-use and handgun-carrying trajectories, and a multinomial logistic regression examined the associations while adjusting for covariates. Analyses were conducted in 2020.

Results: Trajectories of all the 4 forms of substance use were associated with handgun-carrying trajectories. Specifically, the risk of being in the declining trajectory of handgun carrying (compared with that of being in the very-low trajectory) was higher for participants who were in the decreasing trajectories of smoking, drinking, marijuana use, and hard drug use and lower for those who were in the increasing trajectory of drinking. Inversely, the risks of being in the low and high-increasing trajectories of handgun carrying (compared with that of being in the very-low trajectory) were higher for participants who were in the increasing trajectory of hard drug use.

Conclusions: Both substance use and gun carrying are developmentally heterogeneous phenomena. Varied forms of substance use should be targeted to counter the distinct gun carrying patterns.
Am J Prev Med 2021;000(000):1−8. © 2021 American Journal of Preventive Medicine. Published by Elsevier Inc. All rights reserved.

INTRODUCTION

Gun violence is a major threat to public safety and health in the U.S. The burden of interpersonal gun violence falls disproportionately on the young and minority groups.[1,2] An important precursor for interpersonal gun violence is gun carrying, especially handgun carrying among inner-city youth aged 15−24 years.[3−5] Trends in youth homicides in the U.S. have closely tracked trends in youth gun carrying.[6]

To address youth gun carrying, research has identified the risk factors at multiple ecologic levels (e.g., individual, relational, and contextual), and substance use is widely recognized as one of the strongest behavioral correlates.[7−15] The interlinking of substance use and youth gun carrying is particularly concerning because substance use puts youth at heightened risk to be assaulted or to perpetrate violence (e.g., in the context of obtaining or using illicit drugs). Carrying a firearm or weapon provides a sense of false invulnerability and may escalate the level of violence and injuries in potential conflicts.[16−18]

Several theoretical perspectives explain the comorbidity between substance use and gun carrying.[19,20] First, shared antecedents contribute to both behaviors (e.g., neuropsychological deficits, socioeconomic disadvantage, and

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interactions with delinquent peers). Second, psychopharmacological effects (e.g., impaired judgment, impulsivity, and agitation) resulting from substance use lead to gun carrying and violence. Third, the relationship may be economically compulsive. Drug users engage in crime and violence to secure money for costly drugs. Fourth, the criminalization of drug use generates a culture of self-protection and violence among drug users, sellers, and producers in the illegal market. As a reciprocal process, gun carrying generates negative repercussions in the life course (e.g., exclusion from conventional peers and social institutions and the endorsement of deviant lifestyles and self-identity), which in turn exacerbate substance use.[21,22] In brief, substance use and youth gun carrying are not only separate health concerns but their comorbidities also synergistically contribute to more severe safety and health problems.

However, there are still knowledge gaps that preclude the targeted interventions to reduce this comorbidity. Most of the extant research on this issue is cross-sectional and treats gun carrying and substance use as dichotomous phenomena (i.e., gun carrier versus noncarrier and substance user versus nonuser). Yet, individuals initiate, persist, and desist from gun carrying and substance use at varying times, paces, and intensities, and a developmental approach could better elucidate the unfolding of these behaviors. A small number of studies have accounted for developmental heterogeneity and estimated longitudinal trajectories of gun carrying and substance use, but the 2 series of trajectories have not been examined simultaneously.[14,23,24] In addition, previous research has found mixed evidence that the associations between substance use and gun-related behaviors vary according to the type of substance use under investigation.[20] Thus, it is important to explore how the comorbidity varies over the life course and across substance types.

METHODS

Study Sample

Data for this study came from the National Longitudinal Survey of Youth 1997 (NLSY97). The NLSY97 consists of a nationally representative sample of 6,748 respondents (born between January 1, 1980 and December 31, 1984) during the initial survey round. The original sample was 51% male and 49% female, and the racial/ethnic composition was 69% White, 16% Black, 14% Hispanic, and 1% other race/ethnicity. The NLSY97 cohort has been surveyed annually between 1997 and 2011, and since then, it has been surveyed biennially. This analysis used data from Rounds 1 to 16. The mean age of study participants was 14.3 years at Round 1 or in 1997 (with a range of 12−18 years) and 31.0 years at Round 16 or in 2013 (with a range of 28−34 years). The overall retention rate for Round 16 was 78.3%.[25]

Measures

From Round 1 to 15 of the NLSY97, the respondents were queried: *Have you carried a handgun in the past 12 months (Round 1) or since the last interview? When we say handgun, we mean any firearm other than a rifle or shotgun. Please don't include times you carried a handgun because it was part of your work duties.* Responses were coded 1 for *yes* and 0 for *no* at each round. Appendix Text 1 (available online) provides a further discussion on the validity of the measure.

At each round of data collection, the respondents were asked whether and on how many days they smoked a cigarette during the past 30 days. Responses were coded 1 for *yes* and 0 for *no* for a prevalence measure and counted on the number of days a respondent smoked for a frequency measure.

The respondents were asked whether and on how many days they had ≥1 drinks of an alcoholic beverage during the past 30 days. For a prevalence measure, responses were coded 1 for *yes* and 0 for *no*. A frequency measure counted the number of days a respondent drank alcoholic beverages during the past month.

Given the relatively lower rate of use than smoking and drinking, a prevalence measure was used to assess whether a participant used marijuana, even if only once, since the last interview. Responses were coded 1 for *yes* and 0 for *no* at each round.

Given the very low rate of use, the respondents were asked whether they used any drugs such as cocaine or crack or heroin or any other substance not prescribed by a doctor to get high or to achieve an altered state since the last interview. Responses were coded 1 for *yes* and 0 for *no*.

Both time-stable and time-varying covariates were included, which represented important sociodemographic characteristics or confounders that may influence both substance use and handgun carrying. Being male (reference group is female), African American, Hispanic, and other race/ethnicity (reference group is White) were included as binary variables. Age at Round 1 was included because the NLSY97 respondents were born between 1980 and 1984. Additional binary variables captured whether a respondent was a victim of repeated bullying before age 12 years and their exposure to gun violence before age 12 years. Regarding time-varying covariates, because individuals could move across different geographic regions and in and out of an urban area, a participant was allocated into the geographic region where they spent the most time across 16 rounds of data collection; the percentage of time spent in an urban area was also calculated. Similarly, mean scores were calculated across the study period for income from wages and salaries, mental health status (a 5-item short version of the Mental Health Inventory), being arrested, gangs in the neighborhood or where they went to school, and being the victim of a violent crime (e.g., physical or sexual assault or robbery).

Statistical Analysis

First, longitudinal trajectories of handgun carrying and varied forms of substance use were estimated using Mplus, version 8. A key rationale for group-based trajectory modeling is that heterogeneity in the behaviors of interest over time can be summarized into distinct developmental trajectories or pathways that are shaped by different ages of onset, peak timings and magnitudes, and escalation/de-escalation patterns. To avoid having just a small percentage of people determine the shape of the trajectories at the tails, the lower range of the trajectories was set at age 15 years (or

age 16 years for hard drug use), and the upper range was set at age 29 years (Appendix Text 2, available online, provides additional details). Following Nagin's 2-stage model selection process, the optimal number of groups to include in the model was chosen first, balancing model fit and interpretability. The preferred order of the polynomial specifying the within-individual change for each trajectory was then refined given the first-stage decision on the number of groups.[26] When estimating group-based trajectories, Mplus handles missing data using full information maximum likelihood estimation.

Second, Stata, version 15.1, was used to perform cross-tabulation with chi-square tests to determine whether trajectory group memberships for handgun carrying and varied forms of substance use differed by sex, race/ethnicity, geographic region, and urbanicity. Cramer's V was used to measure the strengths of the bivariate associations between handgun carrying and varied forms of substance-use trajectories. Third, a multinomial logistic regression of handgun-carrying trajectories on smoking, drinking, marijuana use, and hard drug use trajectories was estimated while adjusting for covariates. Multiple imputation by chained equations was used to handle missing data in the multinomial logistic regression analysis. Statistical testing was 2-sided with a threshold of $p<0.05$. Analyses were conducted in 2020.

RESULTS

Figure 1 shows that a 5-group model best represented handgun-carrying patterns among U.S. youth. As expected, the vast majority of the participants (72.1%) exhibited a very low probability of carrying a handgun over the study period. The declining trajectory (15.6%) began with a medium probability of carrying during adolescence that dropped off during emerging and young adulthood. The bell-shaped trajectory (5.5%) was characterized by a relatively low probability of carrying during adolescence, a transient increase during emerging
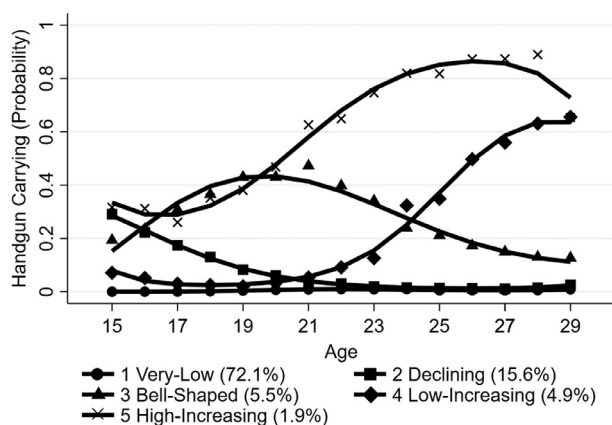

Figure 1. Handgun-carrying trajectory groups across adolescence and young-established adulthood among the NLSY97 sample in the U.S.

NLSY97, National Longitudinal Survey of Youth 1997.

adulthood, and a return to a low probability in young adulthood. In addition, the low-increasing trajectory (4.9%) began with a low probability of carrying during adolescence that increased in emerging and young adulthood, and the high-increasing trajectory (1.9%) began with a medium probability that further increased to very high probability in emerging and young adulthood. Appendix Figure 1 (available online) displays the selected, best trajectory models for smoking, drinking, marijuana use, and hard drug use. Results were substantively similar when using either the prevalence or frequency measure of smoking and drinking. For consistency across substance use measures, results using the prevalence measure were presented.

Table 1 shows that significant relationships existed between handgun-carrying trajectories and sex, geographic region, and urbanicity. Male respondents were more likely to follow 1 of the 4 active handgun-carrying trajectories, whereas 92.3% of the female respondents belonged to the very-low trajectory (compared with 69.5% of the male respondents). Respondents in the South were less likely to follow the very-low trajectory and more likely to follow one of the higher-use trajectories than those in other geographic regions; by contrast, respondents in the Northeast were less likely to be in any of the 4 active trajectories than those of other geographic regions. Moreover, individuals in rural areas were more likely to be in one of the active handgun-carrying trajectories. However, race/ethnicity was not significantly correlated with handgun-carrying trajectories. Appendix Tables 1−4 (available online) report similar information for the estimated substance-use trajectories.

Table 2 shows the cross-trajectory memberships for handgun carrying, conditional on substance-use trajectories. Results from the chi-square tests indicated that all the 4 forms of substance use were significantly correlated with handgun carrying in a bivariate sense when heterogeneities in both behaviors were accounted for. Yet, the strengths of these associations appeared relatively weak, with Cramer's V ranging from 0.06 to 0.09. In addition, individuals in the very-low handgun-carrying trajectory were most likely to be in the very-low trajectories of all forms of substance use; inversely, individuals in the high-increasing handgun-carrying trajectory were most likely to follow the high or high-increasing trajectories of varied forms of substance use.

Results from the multinomial logistic regression analysis are presented in Table 3. The expected risk of being in the declining trajectory of handgun carrying (compared with that of the very-low trajectory) was higher for participants who were in the decreasing or medium-decreasing trajectories of smoking (RRR=1.39, 95% CI=1.01, 1.93), drinking (RRR=1.94, 95% CI=1.30, 2.89),

Table 1. Sociodemographic Characteristics Across Handgun-Carrying Trajectory Groups in the U.S.

Variables	Very low (*n*=5,403), *n* (%)	Declining (*n*=592), *n* (%)	Bell shaped (*n*=334), *n* (%)	Low increasing (*n*=266), *n* (%)	High increasing (*n*=109), *n* (%)	Total (N=6,704), *n* (%)
Sex						***
Male	2,391 (69.5)	453 (13.2)	299 (8.7)	195 (5.7)	102 (3.0)	3,440 (100)
Female	3,012 (92.3)	139 (4.3)	35 (1.1)	71 (2.2)	7 (0.2)	3,264 (100)
Race						n.s.
Black	862 (80.0)	89 (8.3)	73 (6.8)	40 (3.7)	14 (1.3)	1,078 (100)
Hispanic	751 (81.8)	88 (9.6)	43 (4.7)	27 (2.9)	9 (1.0)	918 (100)
Other	68 (84.0)	8 (9.9)	1 (1.2)	2 (2.5)	2 (2.5)	81 (100)
White	3,722 (80.5)	407 (8.8)	217 (4.7)	197 (4.3)	84 (1.8)	4,627 (100)
Region						***
Northeast	1,052 (85.8)	92 (7.5)	46 (3.8)	30 (2.5)	6 (0.5)	1,226 (100)
North Central	1,380 (80.9)	167 (9.8)	73 (4.3)	61 (3.6)	25 (1.5)	1,706 (100)
South	1,826 (77.6)	214 (9.1)	145 (6.2)	115 (4.9)	54 (2.3)	2,354 (100)
West	1,145 (80.8)	119 (8.4)	70 (4.9)	60 (4.2)	24 (1.7)	1,418 (100)
Urbanicity						***
Urban	4,326 (81.7)	436 (8.2)	263 (5.0)	198 (3.7)	73 (1.4)	5,296 (100)
Rural	1,071 (76.5)	155 (11.1)	70 (5.0)	68 (4.9)	36 (2.6)	1,400 (100)

Note: Boldface indicates statistical significance (***$p<0.001$). Each value in the table indicates the number of respondents in a sociodemographic group who follow a particular trajectory (or the total). The percentages in parentheses indicate row percentages. Chi-square tests were used to determine whether trajectory group membership varies by sociodemographic characteristics.
n.s., not significant.

Table 2. Cross-Trajectory Memberships for Handgun Carrying, Conditional on Multiple Forms of Substance-Use Trajectories

	% Belonging to each handgun-carrying trajectories					
Variables	Very low	Declining	Bell shaped	Low increasing	High increasing	Total
Smoking trajectories*** (Cramer's V=0.092)						
Very low	86.2	5.8	2.9	3.8	1.3	100
Decreasing	75.4	10.6	7.6	4.6	1.8	100
Increasing	80.5	9.0	4.7	4.6	1.3	100
High	73.9	12.8	7.3	3.7	2.3	100
Drinking trajectories*** (Cramer's V=0.074)						
Very low	86.0	6.9	3.3	3.1	0.8	100
Medium decreasing	77.0	13.4	5.4	3.1	1.2	100
Increasing	85.4	5.2	3.2	4.5	1.7	100
High increasing	77.8	9.5	6.3	4.3	2.1	100
Marijuana use trajectories*** (Cramer's V=0.076)						
Very low	83.7	7.0	3.7	4.3	1.4	100
Decreasing	74.2	13.1	7.7	3.3	1.7	100
Increasing	80.5	9.8	4.3	4.3	1.2	100
High	75.4	10.3	7.8	3.8	2.8	100
Hard drug use trajectories*** (Cramer's V=0.056)						
Very low	81.8	8.2	4.5	4.1	1.4	100
Decreasing	72.0	14.5	8.6	2.2	2.8	100
Bell shaped	74.8	13.6	6.1	4.2	1.3	100
Increasing	69.0	11.9	7.3	6.9	5.0	100
High	77.8	8.5	8.5	2.0	3.3	100

Note: Boldface indicates statistical significance (***$p<0.001$). Chi-square tests were used to determine whether handgun-carrying trajectory group membership varies by smoking, drinking, marijuana use, and hard drug use trajectories. Cramer's V indicates the strength of the relationship between 2 nominal variables.

Table 3. Multinomial Logistic Regression of Handgun-Carrying Trajectories on Multiple Forms of Substance-Use Trajectories

Variables	Declining, RRR (CI)	Bell shaped, RRR (CI)	Low increasing, RRR (CI)	High increasing, RRR (CI)
Smoking				
Very low (ref)				
Decreasing	**1.39 (1.01, 1.93)***	**2.08 (1.38, 3.13)**[***]	1.34 (0.86, 2.09)	1.31 (0.63, 2.70)
Increasing	1.31 (0.89, 1.91)	1.07 (0.63, 1.81)	1.06 (0.64, 1.78)	0.84 (0.34, 2.07)
High	**1.73 (1.33, 2.25)**[***]	**1.74 (1.22, 2.48)**[**]	1.15 (0.79, 1.69)	1.77 (0.99, 3.15)
Drinking				
Very low (ref)				
Medium-decreasing	**1.94 (1.30, 2.89)**[**]	1.59 (0.89, 2.84)	1.14 (0.61, 2.11)	1.12 (0.35, 3.55)
Increasing	**0.62 (0.40, 0.95)***	0.88 (0.49, 1.59)	1.27 (0.75, 2.15)	2.17 (0.83, 5.68)
High increasing	1.23 (0.86, 1.76)	**1.73 (1.05, 2.84)***	1.33 (0.81, 2.19)	1.76 (0.71, 4.41)
Marijuana use				
Very low (ref)				
Decreasing	**1.36 (1.01, 1.83)***	**1.60 (1.09, 2.35)***	0.79 (0.49, 1.26)	1.09 (0.55, 2.17)
Increasing	1.10 (0.74, 1.65)	0.76 (0.43, 1.36)	0.75 (0.42, 1.33)	0.44 (0.15, 1.24)
High	0.87 (0.60, 1.26)	1.03 (0.65, 1.64)	0.82 (0.47, 1.43)	1.15 (0.53, 2.50)
Hard drug use				
Very low (ref)				
Decreasing	**1.95 (1.21, 3.16)**[**]	1.57 (0.82, 2.99)	1.13 (0.47, 2.73)	2.45 (0.84, 7.16)
Bell-shaped	0.85 (0.49, 1.49)	0.52 (0.24, 1.13)	0.68 (0.25, 1.80)	0.49 (0.12, 2.10)
Increasing	1.17 (0.65, 2.10)	1.08 (0.50, 2.34)	**2.60 (1.28, 5.29)**[**]	**5.60 (2.24, 14.03)**[***]
High	0.72 (0.35, 1.48)	0.91 (0.41, 2.04)	0.62 (0.17, 2.23)	1.56 (0.42, 5.81)
Race				
White (ref)				
Black	1.00 (0.76, 1.33)	1.37 (0.97, 1.93)	0.95 (0.64, 1.40)	0.95 (0.50, 1.82)
Hispanic	1.21 (0.92, 1.59)	0.89 (0.61, 1.30)	0.69 (0.45, 1.07)	0.65 (0.31, 1.37)
Other	1.08 (0.49, 2.36)	0.22 (0.03, 1.66)	0.57 (0.14, 2.41)	1.27 (0.27, 5.90)
Male	**3.68 (2.96, 4.57)**[***]	**9.75 (6.72, 14.16)**[***]	**2.81 (2.09, 3.80)**[***]	**14.16 (6.42, 31.22)**[***]
Age	0.99 (0.93, 1.06)	**1.10 (1.01, 1.20)***	**0.88 (0.80, 0.96)**[**]	0.90 (0.78, 1.03)
Region				
Northeast (ref)				
North Central	**1.42 (1.07, 1.88)***	1.36 (0.91, 2.04)	1.50 (0.95, 2.35)	**3.16 (1.27, 7.83)***
South	**1.41 (1.07, 1.86)***	**2.29 (1.58, 3.32)**[***]	**2.36 (1.54, 3.60)**[***]	**6.20 (2.61, 14.75)**[***]
West	**1.39 (1.03, 1.89)***	**1.86 (1.23, 2.81)**[**]	**2.19 (1.38, 3.48)**[**]	**5.02 (1.99, 12.68)**[**]
Income	1.01 (0.99, 1.02)	**1.02 (1.01, 1.03)**[***]	**1.04 (1.02, 1.05)**[***]	**1.05 (1.04, 1.07)**[***]
Urbanicity	**0.45 (0.34, 0.59)**[***]	**0.55 (0.37, 0.80)**[**]	**0.42 (0.29, 0.63)**[***]	**0.26 (0.14, 0.46)**[***]
Poor mental health	0.96 (0.74, 1.24)	1.39 (0.99, 1.94)	0.84 (0.57, 1.25)	1.02 (0.55, 1.89)
Gang in neighborhood or school	**2.34 (1.56, 3.51)**[***]	**4.06 (2.49, 6.62)**[***]	**3.05 (1.72, 5.41)**[***]	2.35 (0.89, 6.17)
Police arrest	**6.29 (3.03, 13.06)**[***]	**6.38 (2.66, 15.28)**[***]	1.04 (0.25, 4.38)	2.34 (0.41, 13.36)
Victim of repeated bullying before age 12 years	**1.24 (1.01, 1.53)***	0.91 (0.68, 1.22)	**1.46 (1.09, 1.97)***	0.91 (0.56, 1.48)
Exposure to gun violence before age 12 years	**1.54 (1.17, 2.03)**[**]	**1.97 (1.42, 2.75)**[***]	1.39 (0.90, 2.14)	**2.04 (1.14, 3.68)***
Violent victimization	1.49 (0.86, 2.57)	**3.32 (1.80, 6.10)**[***]	1.17 (0.49, 2.78)	**3.57 (1.19, 10.73)***

Note: Boldface indicates statistical significance (*$p<0.05$, **$p<0.01$, ***$p<0.001$). The very-low trajectories are the reference groups in the multinomial regression.

marijuana use (RRR=1.36, 95% CI=1.01, 2.83), and hard drug use (RRR=1.95, 95% CI=1.21, 3.16) as well as those in the high trajectory of smoking (RRR=1.73, 95% CI=1.33, 2.25) and lower for those who were in the increasing (RRR=0.62, 95% CI=0.40, 0.95) trajectory of drinking. When comparing the bell-shaped trajectory with the very-low trajectory, the expected risk was higher for respondents who were in the decreasing

trajectories of smoking (RRR=2.08, 95% CI=1.38, 3.13) and marijuana use (RRR=1.60, 95% CI=1.09, 2.35) and for those in the high or high-increasing trajectories of smoking (RRR=1.74, 95% CI=1.22−2.48) and drinking (RRR=1.73, 95% CI=1.05, 2.84). With respect to the low-increasing and high-increasing trajectories (compared with the very-low trajectory), the expected risks were higher for respondents who were in the increasing trajectory of hard drug use (RRR=2.60, 95% CI=1.28, 5.29; RRR=5.60, 95% CI=2.24, 14.03). Regarding the covariates, it is worth noting that poor mental health was not associated with a higher risk of being in any of the active handgun-carrying trajectories. Early exposure to gun violence was associated with an early initiation of handgun carrying, and violent victimization was associated with an early initiation and a prolonged duration of handgun carrying. In addition, police arrest appeared to be associated with the 2 generally declining handgun-carrying trajectories.

DISCUSSION

Substance use is one of the most important risk factors for youth gun carrying; yet, few studies have disaggregated gun carrying and varied forms of substance use within individuals and examined their dynamic interrelationships over time. Using panel data from a nationally representative sample of U.S. youth, this research advanced the current literature in 2 meaningful ways.

First, this research showed the significance of understanding gun carrying and substance use as developmentally heterogeneous phenomena. Results from the group-based trajectory analyses revealed that individuals who carry firearms and use substances initiate, escalate, de-escalate, and desist from such behaviors at varying times and paces; a dichotomy of carrier versus noncarrier or user versus nonuser oversimplifies the complexity and temporal variability in these behaviors. Specifically, among active youth gun carriers, more than half (i.e., 15.6% of 27.9%) followed the declining trajectory. This is consistent with previous findings that youth gun carrying can be episodic and be driven by the need for self-protection, dispute resolution, or status seeking at the peak of the age−crime curve.[8,27,28] It suggests that interventions should be designed with malleability in mind and avoid potentially labeling effects. A treatment-oriented approach (e.g., relationship skills education and family support services) may be more appropriate for these youth than deterrence-based punitive sanctions (e. g., zero-tolerance policies).[3,29] By contrast, a small proportion of early starters continued and evolved into high-intensity, persistent carriers. In addition to stabilities in the risk factors that lead to the early initiation,

negative consequences of risky gun carrying may push those individuals into a net of delinquency and violence, diminishing opportunities for breaking the chain of cumulative continuity.[21,22,30] Individuals following the bell-shaped trajectory experimented with carrying a firearm longer than those in the declining trajectory but managed to terminate the behavior eventually. Moreover, emerging risk factors in young adulthood may be associated with the late-initiating, low-increasing trajectory. Overall, the findings suggest the importance of understanding the distinct life-course features of gun carrying (e.g., age of onset, timing, duration, intensity, and escalation/de-escalation) and implementing preventive interventions to potentially address each of these features.

When developmental heterogeneity is considered, being male, not living in the Northeast, and living in a rural area are associated with memberships in one of the active handgun-carrying trajectories, which is consistent with previous findings from cross-sectional studies.[7,11,31] Yet, race is not significantly associated with trajectory group membership. This could mean that racial/ethnic status may not affect how gun carrying unfolds in the life course, suggesting that racially targeted youth gun−carrying reduction strategies may not be efficacious at the population level.

Second, this research simultaneously investigated the longitudinal relationships between varied forms of substance use and youth gun carrying and found limited evidence that any particular substance had an overwhelmingly strong association with youth gun carrying. However, the overall similar magnitudes of these associations do not preclude targeted strategies of reducing youth gun carrying following distinct trajectories.

Individuals in the declining trajectory of handgun carrying were more likely to follow the decreasing trajectories of smoking, drinking, marijuana use, and hard drug use and less likely to follow the increasing trajectory of drinking, suggesting that public health interventions should target multiple forms of substance use to facilitate desistance from risky gun carrying. Although being in the high trajectory of smoking was also associated with membership in the declining trajectory, it may reflect that early onset of smoking co-occurs with early initiation of gun carrying and the addictive nature of smoking. Inversely, the low-increasing and high-increasing trajectories of gun carrying were only associated with the increasing trajectory of hard drug use. This suggests that to halt the late initiation or mitigate the exacerbation of persistent gun carrying, special attention may be placed on hard drug use. It may be good clinical practice to inquire about gun carrying when an increasing pattern of hard drug use is observed for young patients.

With respect to the bell-shaped trajectory, early onset of smoking and drinking may co-occur with early initiation and a transient increase of gun carrying, whereas the decreasing trends of smoking and marijuana use characterize the latter part of the trajectory. In brief, the new findings provide a far richer (and yet comprehensible) summary of the relationships between the 2 behaviors than the static associations between dichotomous measures of gun carrying and substance use at a single time point.

Limitations

First, youth gun carrying and substance use were self-reported and were subject to recall or social desirability bias. Yet, the overall prevalence of handgun carrying and substance use in the NLSY97 was comparable with those in other national studies, supporting the validity of the included measures.[32,33] Second, mental health status and violent victimization were not assessed at each round of data collection, although the average scores covered the entire study period. Third, although several of the most important correlates of gun carrying were controlled for, omitted variable bias may still exist. Caution is required when drawing causal conclusions because reverse causality is possible. Finally, group-based trajectory modeling only approximates reality through the identification of clusters of individuals following similar trajectories over time; trajectories may not be interpreted as distinct entities.[34]

CONCLUSIONS

This study highlights that gun carrying and substance use are heterogeneous phenomena in the life course. Varied forms of substance use should be targeted to counter the distinct gun carrying patterns and thus the comorbidity of the 2 behaviors. As early intervention is critical to mitigating disease progression, an important direction for future research is to develop ways to identify early in life which youth are most likely to follow the higher-risk trajectories of substance use and gun carrying and provide them with age- and individual-appropriate interventions.

SUPPLEMENTAL MATERIAL

Supplemental materials associated with this article can be found in the online version at https://doi.org/10.1016/j.amepre.2021.02.015.

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