



Original article

Longitudinal Heterogeneity in Handgun-Carrying Behavior Among Urban American Youth: Intervention Priorities at Different Life Stages

 Beidi Dong, Ph.D.^{a,*}, Sara F. Jacoby, Ph.D.^b, Christopher N. Morrison, Ph.D.^c, and Douglas J. Wiebe, Ph.D.^d
^a Department of Criminology, Law, and Society, College of Humanities and Social Sciences, George Mason University, Fairfax, Virginia

^b Department of Family and Community Health, School of Nursing, University of Pennsylvania, Philadelphia, Pennsylvania

^c Department of Epidemiology, Mailman School of Public Health, Columbia University, New York City, New York

^d Department of Biostatistics, Epidemiology and Informatics, Perelman School of Medicine, University of Pennsylvania, Philadelphia, Pennsylvania

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 A B S T R A C T

Purpose: To determine longitudinal patterns of handgun-carrying behavior among urban American youth and identify modifiable risk factors associated with distinct carrying patterns that should be targeted at different life stages.

Methods: Using panel data from the National Longitudinal Survey of Youth 1997, we estimated longitudinal trajectories of handgun carrying among urban Americans, who carried a handgun at least once between 1997 and 2011 (N = 1,574). Multinomial logistic regression analyses examined risk factors associated with handgun-carrying trajectory groups during late adolescence (ages 16–20), emerging adulthood (ages 20–24), and young established adulthood (ages 24–28).

Results: Group-based trajectory analyses identified four groups: Declining (35.0%, N = 560), bell-shaped (35.5%; N = 561), late-initiating (19.6%; N = 303), and high-persistent (9.9%; N = 150). During late adolescence, lower risks of mental health problems, hard drug use, police arrest, and presence of a gang in the neighborhood or school differentiated the late-initiating group from the other higher risk groups. During emerging and young established adulthood, higher risks of alcohol use, police arrest, and presence of a gang in the neighborhood or school were associated with trajectory groups with higher likelihood of handgun carrying than the declining group.

Conclusions: There are more than one profile of adolescents and young adults who carry handguns. Preventive interventions should have distinct priorities that address different patterns of handgun-carrying behavior at different life stages.

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IMPLICATIONS AND CONTRIBUTION

This study identified four longitudinal trajectories of handgun-carrying behavior among urban American youth. Findings suggest that adolescents and young adults should not be assumed to follow one single profile in their gun-carrying behaviors. Distinct intervention strategies should address different patterns of handgun carrying at different life stages.

Gun violence causes alarmingly high rates of mortality and morbidity among adolescents and young adults in the United States. For individuals between 15 and 29, homicide is the third leading cause of death (following unintentional injury and suicide) and 87% of homicide deaths involve a firearm [1]. In 2016, 7,111

young people aged 15–29 were killed by gunshot assault (or approximately 20 each day); for each individual that dies of a gunshot assault, eight more will survive, undergoing extensive treatment in hospital emergency departments and prolonged recovery both physically and psychologically [2].

An important precursor of gun violence is gun-carrying behavior [3,4]. Trends in youth homicide in the United State have closely tracked trends in youth gun carrying [5]. Empirical studies have demonstrated that carrying a handgun or other weapon increases the likelihood of assault-related injuries and hospitalization [6–8]. In addition to violent injuries, handgun carrying during adolescence

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* Address correspondence to: Beidi Dong, Ph.D., Department of Criminology, Law, and Society, College of Humanities and Social Sciences, George Mason University, 354 Enterprise Hall, 4400 University Drive, MS 4F4, Fairfax, VA 22030.

E-mail address: bdong@gmu.edu (B. Dong).

and young adulthood leads to other negative and health-related outcomes such as low educational achievement [9].

Previous research supports a range of rationales for why adolescents and young adults carry weapons. The perceived need for self-protection and the resolution of disputes are cited as common reasons, particularly in dangerous environments and when youth are involved in criminal activities [7,10,11]. Gun-carrying youth may also be more likely to engage in or escalate violent exchanges, because possession of a gun gives them additional courage to go places they might otherwise avoid, or provides a sense of “false” invulnerability that emboldens them in conflicts [7]. Gun carrying and gun violence may also encourage pervasive gun carrying throughout social networks, as gun violence (and fear of gun violence) spreads across individuals in a process similar to an infectious disease [11,12].

Data from large-scale national studies reveal notable levels of gun-carrying behavior among American youth. According to the Youth Risk Behavior Surveillance System (YRBSS), 5.7% of high school students in the United State reported carrying a firearm in the preceding 30 days in 2001 [13]. The most recent YRBSS findings reported that 4.8% of students had carried a gun on at least 1 day (excluding gun carrying for hunting or sport) in the 12 months that preceded the 2017 survey [14]. Data from the National Survey on Drug Use and Health suggested that between 2002 and 2013, 3.4% of adolescents aged 12–17 in the United State had carried a handgun in the past year [15]. Using data from the National Longitudinal Survey of Youth 1997 (NLSY97) between 1997 and 2011, between 4% and 6% of urban American youth carried a handgun at a particular age between early adolescence and young adulthood [9].

Previous research on youth gun carrying has focused primarily on differentiating “gun carriers” from “noncarriers” using cross-sectional data. These studies have identified multiple risk factors for gun carrying including: male gender, identification as a racial/ethnic minority, residence in urban environments, previous exposures to violence (including being bullied), alcohol, marijuana or other drug use, mental illness, peer delinquency and gang affiliations, involvement in drug dealing and other criminal activities, family poverty, neighborhood disadvantage, and easy access to guns [11,15–23]. To date, most interventions designed to reduce youth gun carrying have conceptualized gun carrying in this dichotomous way, and are rooted in a deterrence perspective informed by the criminal justice field [4,5]. Although these strategies (e.g., specialized gun suppression units, directed patrols, or focused deterrence) have shown some effectiveness in curtailing illegal gun carrying [24], more coordinated efforts with the public health community could enhance preventive interventions that target multilevel modifiable risk factors for gun carrying and gun violence.

Public health approaches to gun violence typically engage a wide variety of people and institutions to create systems and environments in which violence-prone, or other at-risk people are prevented from the opportunity to carry and shoot a gun [25]. Understanding *heterogeneity* in gun carrying over the life-course is essential to these kinds of preventive interventions. The handful of studies that have examined heterogeneity in the gun-carrying population have shown that individuals differ in the age at which they first carry a gun, the timing and duration of gun carrying, and how these developmental features affect later life outcomes [9,23,26–28]. To date, there has been no research that examines how developmental features of gun carrying may translate as independent trajectory groups of adolescents and young adults that

can inform when, for whom, and on which risk factors to focus intervention efforts.

This current study addresses two primary research questions. First, what are the distinct trajectories of handgun carrying among adolescents and young adults and do carrying patterns differ by gender, race, and geographic regions? Because individuals initiate, escalate, de-escalate, and desist from gun carrying at varying times and at different paces, different trajectories of gun carrying are expected to emerge and associate with different consequences.

Second, what are the modifiable risk factors associated with distinct trajectories of handgun carrying that we should pay particular attention to at different life stages? Adolescents experience stress and anxiety associated with establishing “age-appropriate autonomy” [29], and when combined with risk factors like poor mental health, substance use, gang influence in the neighborhood or school, or involvement in criminal behavior, may increase feelings of uncertainty and insecurity that increase gun carrying at this life stage. These same factors may contribute to gun carrying in emerging and young established adulthood, as individuals continue to grapple with identity explorations during the transition between the dependency of childhood/adolescence and assumption of adult roles and responsibilities [30]. Here, we aim to identify “markers” associated with distinct trajectories that should be targeted during “late adolescence” (ages 16–20), “emerging adulthood” (ages 20–24), and “young established adulthood” (ages 24–28).

Methods

Data and sample

The current study uses data from the NLSY97, a longitudinal panel study designed to document individual transitions in various life domains (e.g., educational and labor market experiences, criminal behavior, and alcohol and drug use) from early adolescence to adulthood. The NLSY97 consists of a nationally representative sample of 8,984 American youth born between 1980 and 1984. Specifically, the overall sample comprises two independent probability samples: A cross-sectional sample of 6,748 respondents, and an oversample of 2,236 African-American and Hispanic respondents. The NLSY97 cohort has been surveyed annually between 1997 (aged 12–18 years) and 2011 (aged 26–32 years) and, since then, biennially. At the time of this analysis, 16 rounds of data are publicly available. The overall retention rate over the 16 waves of data collection is 79.5%.

To ensure that the same set of eligible subjects were included for trajectory and regression analysis, we categorized urban respondents as those who resided in an urban area (as defined by the Census Bureau) as of the survey date of Round 1 data collection. Although, participants could move in and out of an urban area across rounds of data collection, preliminary analysis showed that residence in an urban area was a relatively stable phenomenon in the NLSY97 cohort. For instance, the tetrachoric correlation of urban residence between Round 1 and 2 was 0.99 and that correlation was above 0.85 between Round 1 and 7. Beginning in Round 8, new Census standards were used in categorizing urban residence.

Given that prior research has distinguished gun carriers from noncarriers (i.e., the “ever” vs. “never” dichotomy) and we are particularly interested in the longitudinal heterogeneity among carriers, participants (i.e., among “ever” carriers) who did not carry a handgun between Round 1 and 15 of data collection (N = 203) or

who had missing information on handgun carrying for more than half of the 15 rounds ($N = 125$) were excluded from the analyses. We thus obtained an analysis sample of 1,574 urban American youth (see Appendix A for detailed information on the analysis sample).

Measures

Handgun carrying. Between Round 1 and 15, the NLSY97 subjects were asked: “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.

Mental health status. A five-item short version of the Mental Health Inventory-5 was used to assess how often the respondent reported being nervous, feeling calm and peaceful (reverse coded), feeling downhearted and blue, being happy (reverse coded), and feeling so down in the dumps that nothing could cheer them up [31]. Respondents used a four-point scale to rate the frequency of these feelings in the previous month. A mean score was then calculated (Cronbach’s $\alpha = 0.77$).

Alcohol use. The subjects were asked if and how many days they had one or more drinks of an alcoholic beverage during the last 30 days. For the prevalence measure, responses were coded “1” for yes, and “0” for no. The frequency measure counted the number of days a subject drank alcoholic beverages during the past month.

Marijuana use. The subjects were asked if and how many days they used marijuana during the last 30 days. For the prevalence measure, responses were coded “1” for yes, and “0” for no. The frequency measure counted the number of days a subject used marijuana during the past month.

Hard drug use. The subjects were asked, excluding marijuana and alcohol, if and how many times they used any drugs like cocaine or crack or heroin, or any other substance not prescribed by a doctor, in order to get high or to achieve an altered state since the date of last interview. For the prevalence measure, responses were coded “1” for yes, and “0” for no. The frequency measure counted the number of times a subject used hard drugs during the past year.

Police arrest. As a proxy measure for offending behavior, the subjects were asked: “Since the date of last interview, have you been arrested by the police or taken into custody for an illegal or delinquent offense (do not include arrests for minor traffic violations)?” Responses were coded “1” for yes, and “0” for no.

Gang in neighborhood or school. The subjects were asked if there were any gangs in their neighborhoods or where they went to school. Responses were coded “1” for yes, and “0” for no.

Demographic variables. Income from jobs during the past year was measured by an eight-category variable. Age was included as a continuous variable because the respondents were not born in the same year but across 1980 and 1984; multiple age cohorts thus exist for the NLSY97. Other demographic and control variables that do not vary across time include gender, race, geographic

region, being a victim of repeated bullying before age 12, and exposure to gun violence before age 12.

Statistical analyses

Longitudinal trajectories of handgun carrying were estimated using the Mplus program (Version 8). The rationale behind the technique is that there may be qualitatively different pathways of change over age or time across subgroups within a population. Yet, these groups are not identifiable *ex ante* on the basis of measured characteristics such as gender or race. By summarizing individual differences in the developmental progression of handgun carrying as distinct trajectories, the method distinguishes chance variation across individuals from meaningful differences [32].

We specified a binary logit distribution for the dichotomous outcome. The existence of multiple age-cohorts means that the estimated trajectories will be spread out, using observations from the younger individuals to complete the trajectories in the early years, and using observations from the older individuals to complete the trajectories in the later years. The trajectories at any point in time are supported by the people who have data at that age. We chose to start the lower range at age 15 and end the upper range at age 29. In this way, at least half of all eligible participants were included at each age point, avoiding having just a few people determine the shape of the trajectories at the tails. Following the two-stage model selection process [32], we first chose the optimal number of groups to include in the model on the basis of the Bayesian Information Criterion, results from the likelihood ratio tests [33,34], and model parsimony and interpretability. Then, the model was refined to determine the preferred order of the polynomial, specifying the within-individual change for each trajectory given the first-stage decision on number of groups. To guard against model convergence to local maxima, 2,000 randomized sets of start values were used and we confirmed that the best log-likelihood value was replicated.

Using Stata (Version 15.1; StataCorp 1985–2017), we conducted chi-square tests to determine if trajectory group membership varies by gender, race, and geographic regions. Because not all risk factors were measured at each round of data collection (e.g., mental health status was available only at Round 4, 6, 8, 10, 12, and 14), when identifying modifiable risk factors or “markers” associated with distinct trajectories, we selected three time points at which participants were in late adolescence, emerging adulthood and young established adulthood and when all risk measures were available. At Round 4 (Year 2000), over 97% of the subjects were between ages 16 and 20; at Round 8 (Year 2004), over 97% of the subjects were between ages 20 and 24, and at Round 12 (Year 2008), over 97% of the subjects were between ages 24 and 28. We then used multinomial logistic regression models to examine the relationships between trajectory group membership and risk factors at each of the three rounds. Statistical testing was two-sided with a threshold of $p < .05$.

Results

Table 1 illustrates our sample of predominantly male (75.4%) handgun-carrying young people. African-American, Hispanic, and white subjects accounted for 29.6%, 25.7%, and 43.7% of the analysis sample, respectively. The US South contributed most subjects (39.2%) relative to other regions of the country.

As shown in Figure 1, we found a four-group model that best represents handgun-carrying patterns across adolescence

Table 1
Sociodemographic characteristics across handgun-carrying trajectory groups in the urban United States

Variables	Declining (N = 560)	Bell-shaped (N = 561)	Late-initiating (N = 303)	High-persistent (N = 150)	Total (N = 1,574)
Gender					***
Male	399 (33.6%) (71.3%)	433 (36.5%) (77.2%)	217 (18.3%) (71.6%)	138 (11.6%) (92.0%)	1187 (100%) (75.4%)
Female	161 (41.6%) (28.8%)	128 (33.1%) (22.8%)	86 (22.2%) (28.4%)	12 (3.1%) (8.0%)	387 (100%) (24.6%)
Race					n.s.
Black	162 (34.8%) (28.9%)	166 (35.6%) (29.6%)	95 (20.4%) (31.4%)	43 (9.2%) (28.7%)	466 (100%) (29.6%)
Hispanic	147 (36.3%) (26.3%)	163 (40.3%) (29.1%)	61 (15.1%) (20.1%)	34 (8.4%) (22.7%)	405 (100%) (25.7%)
Other	5 (33.3%) (0.9%)	7 (46.7%) (1.3%)	1 (6.7%) (0.3%)	2 (13.3%) (1.33%)	15 (100%) (1.0%)
White	246 (35.8%) (43.9%)	225 (32.7%) (40.1%)	146 (21.2%) (48.2%)	71 (10.3%) (47.3%)	688 (100%) (43.7%)
Region					n.s.
Northeast	72 (36.6%) (12.9%)	76 (38.6%) (13.6%)	33 (16.8%) (10.9%)	16 (8.1%) (10.7%)	197 (100%) (12.5%)
North Central	109 (34.6%) (19.5%)	113 (35.9%) (20.1%)	63 (20.0%) (20.8%)	30 (9.5%) (20.0%)	315 (100%) (20.0%)
South	230 (37.3%) (41.1%)	209 (33.9%) (37.3%)	126 (20.4%) (41.6%)	52 (8.4%) (34.7%)	617 (100%) (39.2%)
West	149 (33.5%) (26.6%)	163 (36.6%) (29.1%)	81 (18.2%) (26.7%)	52 (11.7%) (34.7%)	445 (100%) (28.3%)

Each value in the table indicates the number of respondents in a sociodemographic group that follow a particular trajectory (or the total). The two percentages in parentheses below each value indicate row and column percentages. Chi-square tests were used to determine if trajectory group membership varies by sociodemographic characteristics. *** $p < .001$, n.s. = not significant.

and young adulthood, optimizing the balance between model fit and interpretability: *the declining trajectory* (35.0%, N = 560) is characterized by relatively high probabilities of handgun carrying during late adolescence but low probabilities during emerging and young adulthood; inversely, *the late-initiating*

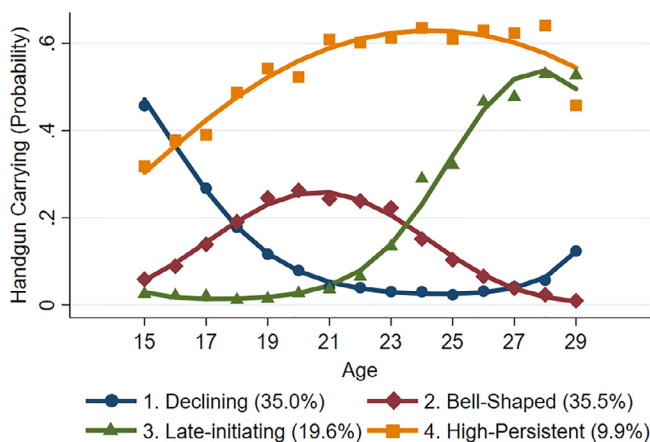


Figure 1. Handgun-carrying trajectory groups across adolescence and young adulthood. The trajectories at any point in time are supported by the people, who have data at that age; for each age-point, data collected across multiple study years are used.

trajectory (19.6%; N = 303) begins with low probabilities during late adolescence that increase in emerging and young adulthood. *The bell-shaped trajectory* (35.5%; N = 561) is characterized by a low probability of handgun carrying during late adolescence, a transient increase in the likelihood of carrying during emerging adulthood, and return to a near-zero level of probability in young adulthood. Finally, *the high-persistent trajectory* (9.9%; N = 150) exhibits consistently high and slightly increasing risk of carrying over time from late adolescence through young adulthood (see Appendix B for additional details on model selection).

Results from the chi-square tests (Table 1) show a significant relationship between trajectory group membership and gender. Males appeared more likely to follow the bell-shaped (36.5% vs. 33.1%) and high-persistent (11.6% vs. 3.1%) trajectories, whereas females were more likely to follow the declining (41.6% vs. 33.6%) and late-initiating (22.2% vs. 18.3%) trajectories. Race and geographic locations were not significantly related to handgun-carrying trajectory groups.

Results from the multinomial logistic regression analyses are shown in Table 2. We presented the models with the prevalence measures of alcohol, marijuana, and hard drug use. Regression results were substantively similar when using either the prevalence or frequency of substance use except that the prevalence of alcohol use (but not frequency) related to trajectory group membership during emerging and young established adulthood.

Table 2

Multinomial regression models for risk factors associated with handgun-carrying trajectory group membership during late adolescence, emerging adulthood and young established adulthood

Variables	Bell-shaped RRR (CI)	Late-initiating RRR (CI)	High-persistent RRR (CI)
<i>Late adolescence</i>			
Poor mental health	0.91 (0.72–1.15)	0.64 (0.48–0.87)**	1.03 (0.71–1.51)
Alcohol use in past 30 days	1.21 (0.92–1.59)	1.01 (0.72–1.39)	1.43 (0.92–2.22)
Marijuana use in past 30 days	0.86 (0.63–1.18)	0.72 (0.48–1.07)	1.08 (0.68–1.73)
Hard drug use since DLI	0.91 (0.60–1.37)	0.52 (0.27–0.99)*	0.78 (0.41–1.50)
Police arrest since DLI	0.70 (0.49–1.01)	0.29 (0.16–0.54)***	0.64 (0.37–1.12)
Gang in neighborhood or school	1.11 (0.84–1.47)	0.79 (0.56–1.12)	1.46 (0.96–2.21)
Income	1.07 (0.93–1.24)	1.02 (0.85–1.22)	1.47 (1.18–1.81)***
Age	1.05 (0.95–1.15)	0.89 (0.79–1.00)	0.97 (0.83–1.13)
<i>Emerging adulthood</i>			
Poor mental health	1.21 (0.95–1.54)	0.81 (0.59–1.10)	1.30 (0.90–1.87)
Alcohol use in past 30 days	1.40 (1.04–1.89)*	1.76 (1.21–2.54)**	1.66 (1.03–2.67)*
Marijuana use in past 30 days	0.96 (0.68–1.34)	0.67 (0.45–1.01)	0.80 (0.49–1.33)
Hard drug use since DLI	1.00 (0.59–1.67)	1.23 (0.66–2.29)	1.48 (0.74–2.99)
Police arrest since DLI	1.02 (0.66–1.59)	0.55 (0.29–1.06)	1.88 (1.07–3.31)*
Gang in neighborhood or school	1.44 (1.02–2.03)*	1.09 (0.71–1.67)	2.00 (1.22–3.30)**
Income	1.10 (1.00–1.22)*	1.05 (0.94–1.18)	1.22 (1.05–1.42)*
Age	1.05 (0.96–1.14)	0.89 (0.80–0.99)*	1.08 (0.94–1.24)
<i>Young established adulthood</i>			
Poor mental health	1.07 (0.83–1.37)	0.90 (0.66–1.22)	1.18 (0.81–1.73)
Alcohol use in past 30 days	1.11 (0.83–1.49)	1.55 (1.08–2.22)*	1.10 (0.69–1.74)
Marijuana use in past 30 days	0.97 (0.70–1.36)	0.73 (0.48–1.11)	1.10 (0.68–1.80)
Hard drug use since DLI	1.74 (0.99–3.05)	1.61 (0.81–3.16)	1.71 (0.74–3.98)
Police arrest since DLI	1.20 (0.72–2.01)	0.84 (0.41–1.73)	2.35 (1.20–4.63)*
Gang in neighborhood or school	1.25 (0.90–1.74)	1.28 (0.86–1.90)	1.74 (1.06–2.84)*
Income	1.14 (1.05–1.24)**	1.23 (1.10–1.38)***	1.20 (1.04–1.38)*
Age	1.06 (0.97–1.15)	0.91 (0.82–1.01)	1.07 (0.94–1.22)

Time-invariant controls (gender, race/ethnicity, geographic region, being a victim of repeated bullying prior to 12 years old, and exposure to gun violence prior to 12 years old) were included when estimating multinomial regression models. For brevity, those coefficients are not reported here. The declining trajectory is the reference group. Study subjects were between ages 16 and 20 in the adolescent models, between ages 20 and 24 in the emerging adulthood models, and between ages 24 and 28 in the young established adulthood models.

CI = confidence interval; DLI = date of last interview; RRR = relative risk ratios.

*** $p < .001$.

** $p < .01$.

* $p < .05$.

Specifically, during late adolescence, poor mental health, hard drug use, and police arrest were associated with a higher risk of being in the declining group compared to the late-initiating group. In models shown in supplemental Table S1, poor mental health, police arrest, and gang in neighborhood/school were also associated with membership in the bell-shaped and high-persistent groups compared to the late-initiating group. During emerging adulthood, alcohol use and gang in neighborhood/school were associated with a higher risk of being in the bell-shaped group when compared to the declining group. In addition, as compared to the declining group, alcohol use characterized the late-initiating group, and alcohol use, police arrest, and gang in neighborhood/school characterized the high-persistent group. During young established adulthood, alcohol use was associated with a higher risk of being in the late-initiating group, and police arrest and gang in neighborhood/school were associated with a higher risk of being in the high-persistent group as compared to the declining group. Throughout the three life stages examined, it appeared that financial capability (i.e., income) was associated with the more severe and persistent trajectories of handgun carrying compared to the declining group.

Discussion

Very few previous studies have attempted to disaggregate gun carrying within individuals over time. Using panel data from

the NLSY97, we found that handgun-carrying behavior varies longitudinally among urban American youth and identified four distinct handgun-carrying trajectories between ages 15 and 29. We also found that key social behavioral characteristics differentially predicted trajectory group membership over time, supporting the need for distinct intervention strategies to reduce risky gun carrying for different people at different times.

A plurality (35.0%) of the respondents followed the declining trajectory, while a smaller percentage (9.9%) followed the high-persistent trajectory. Besides self-protection, adolescent gun carrying may be associated with status-seeking, imitation or striving for “age-appropriate autonomy” [29]. Two developmental processes may contribute to the prolonged duration after an early onset [28,35]: (1) there is stability in the social-behavioral characteristics that lead to the early initiation, and (2) handgun carrying generates a range of negative consequences in the surrounding environment (e.g., coercive and punitive responses from parents or the school system, rejection by peers, or deviant life styles) that set up a temporal contagion process. Yet, continuity in gun carrying is not inevitable, and positive changes are possible [9,36]. The bell-shaped (35.5%) and late-initiating trajectories (19.6%), on the other hand, were not characterized by relatively high probabilities of carrying during adolescence. Life stage-specific risk factors should be associated with the transient increase in the likelihood of carrying for the bell-shaped trajectory during emerging adulthood and the continued increase in the likelihood

of carrying for the late-initiating trajectory through emerging and young adulthood.

Consistent with prior studies that have assessed gun carrying as a static phenomenon cross-sectionally, males appeared more likely than females to be in the more severe and persistent group. Race and geographic locations have also previously been related to gun carrying, but our findings add that among carriers these characteristics were not associated with trajectory group membership. This could mean that racial–ethnic status and geographical locations may not affect how gun carrying unfolds in the life-course. Our findings support interventions that aim to reduce risky gun-related behavior among carriers in general, rather than targeting racially specific or geographically specific behavioral patterns.

To address the second aim of the study, we found that alcohol use, symptoms of poor mental health, and other social and behavioral characteristics were differentially associated with the carrying patterns over time. While addressing mental health need appears especially important among younger subjects, alcohol use appears to be a particularly important risk factor during emerging and young established adulthood. These findings highlight the importance of public health practice and policy interventions that support mental health for youth during stressful and uncertain times, and continue to focus on reducing the well-established connection between alcohol and firearm use among adults [37]. Interventions that reduce criminal offending and presence of a gang in the neighborhood or school seem important for high-risk people across different life stages. It is not surprising that mitigating the chances of conflicts and reducing the needs for self-protection decrease the likelihood of gun carrying throughout the life-course.

In summary, our results suggest different gun violence intervention strategies should apply to people with distinct carrying patterns at different life-stages, and that one size does not fit all. It also suggests that there may be synergistic opportunities from combining criminal justice and public health strategies to prevent risky gun-carrying behavior. Criminal justice interventions such as specialized gun and/or gang suppression units, directed patrols, or focused deterrence may curtail crime-related or gang-related gun carrying and violence ([24,38], and coordinated efforts with the public health community aimed toward mental health needs for youth (e.g., enhanced screening, and access to mental health services) and controlling alcohol use in young adults (e.g., surveillance of alcohol outlets) may offer the greatest impact.

Limitations and strengths

Our study is subject to several limitations. First, we were not able to conclusively distinguish between legal and illegal handgun carrying using the NLSY97 data. Yet, we considered the measure a legitimate indicator of gun-carrying behavior with social and health risks among urban Americans for three reasons: (1) the handgun-carrying questions were asked in the delinquency section of the NLSY97 self-administered questionnaire, preceded and followed by other law-violating behaviors; (2) illegal gun owners/users tend to be urban and they overwhelmingly prefer handguns for their concealability and power [39,40]; and (3) previous research using the NLSY97 data has shown that the handgun-carrying measure was associated with negative outcomes in theoretically expected ways, such as increasing the likelihood of violence and drug sale [9]. Nevertheless, no studies have identified valid approaches to assessing illegal gun carrying over the life-course. Second, and relatedly, handgun carrying was measured by a single

self-reported item and subject to recall or social desirability bias. However, the overall prevalence of handgun carrying in the NLSY97 was found similar to those in other national studies, suggesting the validity of the measurement approach. Third, although we examined several of the most important risk factors for gun carrying, there remain other key considerations for public health interventions. The publicly available NLSY97 data, for instance, have limited information on community characteristics that may influence the likelihood of gun carrying and other risks considered in this study. Fourth, society has changed dramatically over the past two decades with regard to firearm availability, cultural acceptance of violence and exposure to violence on TV/internet, among other issues. It is not clear how reflective the identified trajectory groups and their associated risk factors would be with current youth. Finally, the lack of early-life indicators of risk prevents us from predicting handgun-carrying trajectories; caution is required when drawing causal conclusions regarding the risk factors associated with the trajectories, as the direction of the relationship could not be fully ascertained in the study.

This study also has several important strengths. First, to our knowledge, this is the first study to estimate handgun-carrying trajectories. Although, other large-scale studies such as the National Survey on Drug Use and Health or the YRBSS are appropriate for trend analyses of gun carrying in the United State, only the NLSY97 followed the same group of respondents and investigated their handgun-carrying behavior from 1 year to the next, spanning up to 15 years between their ages of 15–29. Second, the NLSY97 incorporates a nationally representative community sample; thus the results are not constrained by sample selectivity (e.g., in-school or offender sample). Third, we were able to simultaneously examine several of the most important risk factors and identify intervention priorities at different life stages for individuals following distinct trajectories.

Gun violence poses a substantial public health threat to adolescents and young adults in the United State. Effectively reducing gun carrying among youth is crucial for mitigating gun-related morbidity and mortality. We find that adolescents and young adults should not be assumed to follow one single profile in their gun-carrying behaviors. Public health approaches require tailoring to handgun-carrying trajectories that incorporate distinct intervention strategies at different life stages in order to prevent injury and promote health in different groups of urban youth. Based on our findings, we highlight the importance of enhancing mental health screening and services for youth, controlling alcohol use among young adults, and reducing criminal offending and gang influence in school and neighborhood environment throughout the life-course. Intervening early enough is essential to prevent physical or psychological injury or mitigate “disease” progression, especially for high-risk subjects. A particularly important next step is the development of ways to identify early in life which youth are most likely to follow the more severe and persistent trajectories and live with extended exposure to the associated risks.

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Supplementary data

Supplementary data related to this article can be found at doi.org/10.1016/j.jadohealth.2018.09.026.

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