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## Longitudinal pathway from violence exposure to firearm carriage among adolescents: The role of future expectation

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### Abstract

**Introduction**—Exposure to violence is a risk factor for firearm carriage. Youth exposed to violence also have difficulty envisioning positive future outcomes (e.g., educational outcomes), which can increase the likelihood of firearm carriage over time. Researchers, however, have not yet examined whether changes in exposure to violence over time can influence the developmental trajectories of firearm carriage. To address this gap, we (1) examined the longitudinal association between exposure to violence and firearm carriage (grades 9 to 12) and then (2) examined whether changes in future expectations mediated this longitudinal association.

**Method**—The longitudinal association between exposure to violence and firearm carriage through future expectations was examined among 850 adolescents from the Flint Adolescent Study. Participants were recruited from four high schools in a midwestern city in the United States. Parallel latent growth models and latent growth mediation models were estimated.

**Results**—A positive association was observed between the rate of change in exposure to violence and firearm carriage. Exposure to violence also indirectly increased the risk for firearm carriage over time by decreasing future expectation in the 9<sup>th</sup> grade.

**Conclusions**—Our results support the idea that helping youth develop positive attitude about educational success may help reduce firearm carriage. Increasing positive expectations about future may help prevent firearm carriage within the context of violence exposure.

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## Keywords

firearm carriage; future expectations; violence exposure; resilience

Firearm injury and related deaths are a serious public health concern for adolescents living in the U.S. (Grinshteyn & Hemenway, 2016). Firearm injuries are the cause of death for approximately 19 youth per day (Fowler, Dahlberg, Haileyesus, Gutierrez, & Bacon, 2017), with the majority of deaths (approximately 80%) occurring during ages 13 to 17 (Center for Disease Control Prevention, 2016). Firearm carriage is an important risk factor for firearm violence even after controlling for criminal justice involvement, drug use, and mental health outcomes (Carter et al., 2013; Carter et al., 2015; Cunningham et al., 2010). Given the importance of firearm carriage on firearm violence, it is important to elucidate mechanisms that contribute to firearm carriage among youth. Exposure to violence (e.g., violent victimization, witnessing violence) has been documented as a predictor of firearm possession (Molnar, Miller, Azrael, & Buka, 2004; Reid, Richards, & Loughran, 2017; Spano & Bolland, 2011; Spano & Bolland, 2013; Vaughn, Howard, & Harper-Chang, 2017). While the association between exposure to violence and firearm possession is established, psychological mechanisms underlying this link is limited.

Guided by theory and research on adolescent future expectations (*see* Stoddard & Pierce, 2015), anticipating positive future outcomes (e.g., graduating high school) during this life stage is essential to optimal development, psychological well-being, and positive health behavior during late adolescence and emerging adulthood (McDade et al., 2011; Schmid, Phelps, & Lerner, 2011; Wood, Kaplan, & McLoyd, 2007). Exposure to violence, however, is a risk factor that can diminish positive future expectations among adolescents (Bolland, McCallum, Lian, Bailey, & Rowan, 2001; Stoddard, Henly, Sieving, & Bolland, 2011). Moreover, negative future expectations have been associated with increased firearm carriage (Duke, Borowsky, Pettingell, & McMorris, 2011). Given the pattern of results on future expectations, we seek to understand whether future expectations, and specifically future education-related expectations are a key component of the pathway linking exposure to violence with firearm carriage.

## Longitudinal Association between Exposure to Violence and Firearm Possession

The positive associations between exposure to violence and firearm possession is well established (Carter et al., 2013; Carter et al., 2015; Molnar, Miller, Azrael, & Bulka, 2004; Reid et al., 2017; Slovak & Singer, 2001; Spano & Bolland, 2013; Spano, Pridemore, & Bolland, 2012). In a recent study, the odds of carrying a firearm increased by approximately 40% after exposure to violence among adolescents (Beardslee et al., 2018). Reid and colleagues (2017) similarly reported that higher levels of exposure to violence, even after controlling for psychological distress, increased the likelihood of firearm carriage among adolescents. While these studies collectively shed important insights about the immediate and long-reaching effects of early exposure to violence on firearm carriage outcomes among adolescents, researchers have not yet examined whether changes in exposure to violence can

alter the trajectory of firearm carriage risk. That is, it is critical for researchers to assess how changes in exposure to violence can influence the nature of change (i.e., rate of change, direction of change) in firearm carriage risk. Exposure to violence, as documented in previous longitudinal studies can change throughout adolescence (Heinze, Stoddard, Aiyer, Eisman, & Zimmerman, 2017), which may inform how the risk of firearm outcomes unfolds developmentally. To date, researchers have primarily examined whether exposure to violence can predict future firearm carriage (e.g., Beardslee et al., 2018). Testing this longitudinal link is also important for interventionists because decreasing exposure to violence over time may, in turn, lower the risk of firearm carriage over time. Thus, we aim to examine whether the rate of change in exposure to violence influences the rate of change in firearm carriage risk from the 9<sup>th</sup> to 12<sup>th</sup> grade among adolescents residing in Flint, MI. We will also test whether 9<sup>th</sup> grade exposure to violence is associated with the rate of change in firearm carriage risk to determine the influence of early exposure to violence on firearm carriage over time.

### **Exposure to violence, Future Expectations, and Firearm Carriage**

To guide our understanding of how exposure to violence shapes firearm possession, researchers have postulated that high levels of exposure to violence may negatively influence one's cognition about themselves, their social world, and their future (Frankenhuis, Panchanathan, & Nettle, 2016). For instance, researchers have documented that youth who routinely contend with exposure to violence may develop retaliatory attitudes (Copeland-Linder, Johnson, Haynie, Chung & Cheng, 2012), promote a self-protection mindset (Brazina, Agnew, Cullen, & Wright, 2004), and hold beliefs that the world is an unsafe place (Milam, Furr-Holden, & Leaf, 2010). These attitudes, in turn, can deteriorate the youth's expectations about their future and increase violent behaviors (Stoddard et al., 2015), which may increase the likelihood of firearm carriage. While future expectations have been discussed as a potential mediator that can bridge exposure to violence to firearm violence (Duke et al., 2011; Stoddard et al., 2015), this mechanism has not been tested. Thus, we will test if increases in exposure to violence diminishes future expectations, which increases the likelihood of firearm carriage over time.

Expectations about educational and career aspirations may play a vital role in shaping psychological well-being (Schmid, Phelps, & Lerner, 2011; Schmid, Phelps, Mueller, Napolitano, Boyd, & Lerner, 2011) and health behaviors among adolescents (Harris, Duncan, & Boisjoly, 2002; McDade et al., 2011). While positive future expectations are essential to positive youth development and well-being (Stoddard & Pierce, 2015), positive future expectations are also vulnerable to stressful life experiences (Agnew, 1992; Agnew & White, 1992). Among adolescents, for instance, exposure to violence has been associated with diminished expectations about meeting educational goals (Boxer, Edwards-Leeper, Goldstein, Musher-Eizenman, & Dubow, 2003). Higher levels of future career orientation was also associated with decreases in violent behaviors over time (Stoddard et al., 2011). Guided by the empirical literature on exposure to violence and future expectations, adolescents exposed to violence may have difficulty anticipating positive future outcomes (e.g., graduating high school), which may diminish the likelihood of engaging in planning and goal setting (Trask-Tate & Cunningham, 2010). In turn, adolescents with negative future

expectations, within the context of exposure to violence, may pursue risky activities (e.g., firearm carriage) that lead to firearm violence. While little is known about the relation between future expectation and firearm carriage, future orientation has been linked to violent behaviors, including weapon carriage (Bolland, 2003; Bradley & Greene, 2013; Resnick, Ireland, & Borowsky, 2004; Stoddard et al., 2011).

Exposure to violence can also invoke symptoms of trauma, including a shortened time horizon (Graham-Bermann & Seng, 2003). Shortened time horizon has been conceptualized as "...a negative evaluation of what the future offers" (Ratcliffe, Ruddell, & Smith, 2014). Adolescents contending with a foreshortened sense of future may no longer perceive a meaningful future and perceive negative beliefs about their future, such as - "I will not graduate high school," or "I will die before I'm 18" (Ratcliffe et al., 2014). Envisioning negative future outcomes has been associated with a "nothing to lose" mentality, which can promote risky behaviors such as carrying a firearm regardless of risk awareness (Harris, Duncan, & Boisjoly, 2002). Although future expectations are often multifaceted and include expectations about education, career, relationships, and family, expectations about educational outcomes are particularly salient during adolescence (Nurmi, 1987). Expectations about future educational outcomes may play a critical role in behavior choices that influence later adult outcomes. It is, therefore, conceptually reasonable that future expectations about educational outcomes may undergird the association between exposure to violence and firearm carriage among adolescents and play a critical role in shaping the developmental and psychological consequences of exposure to violence.

## Confounding Effects

It is also important to mention that socio-demographic correlates (e.g., sex, socio-economic status, and age), internalizing symptoms, and alcohol, tobacco, and other drug use (ATOD) are person-level characteristics that can influence firearm carriage. For instance, these demographic and health-related factors have been consistently associated with firearm carriage among youth (see Schmidt et al., 2019). Moreover, internalizing symptoms (e.g., Lee & Neblett, 2017) and ATOD use (e.g., Derefinko et al., 2016) undergo developmental changes throughout adolescence. To mitigate confounding bias, it is crucial for researchers to adjust for sex, socioeconomic status, age, internalizing symptoms, and ATOD when examining the effect of exposure to violence on firearm carriage.

## Current study

While exposure to violence is longitudinally associated with firearm carriage (Beardslee et al., 2018), researchers have not yet empirically investigated whether temporal changes in exposure to violence predict the trajectory of firearm carriage risk from adolescence to emerging adulthood. Further, our understanding of future expectations as a mediator to the longitudinal association between exposure to violence and firearm carriage is limited. Our model (see Figure 1) represents one way of understanding the association between exposure to violence and firearm carriage. To date, exposure to violence has been associated with diminished future expectations (Stoddard et al., 2015), while diminished future expectations have been associated with firearm carriage (Duke et al., 2011). To add to our understanding

of youth firearm carriage, our study consisted of two aims. First, we examined whether longitudinal changes in exposure to violence can increase the trajectory of firearm carriage risk from grades 9 to 12. Second, we examined whether developmental changes in future expectations mediated this association.

## Method

### Participants

We analyzed data from the Flint Adolescent Study (FAS; Zimmerman, Caldwell, & Bernat, 2002) during waves 1 (1994–1995;  $M_{\text{age}} = 14.9$ ,  $SD_{\text{age}} = .0.64$ ), 2 (1995–1996;  $M_{\text{age}} = 15.8$ ,  $SD_{\text{age}} = 0.64$ ), 3 (1996–1997;  $M_{\text{age}} = 16.8$ ,  $SD_{\text{age}} = 0.63$ ), and 4 (1997–1998;  $M_{\text{age}} = 18.0$ ,  $SD_{\text{age}} = 0.63$ ). Our sample initially included 850 participants attending one of four public high schools in Flint, Michigan in 1994. The overarching goal of the original study was to investigate risk and resilience factors among youths who were at risk for school dropout and substance use. To be eligible for the original study, participants had a grade point of 3.0 or lower at the end of the eighth grade, were not diagnosed by the school as having an emotional or developmental impairment, and self-identified as African American ( $n=681$ ) or White ( $n=142$ ).

The sample for the current analysis includes 566 participants due to missing data (i.e., missing on exogenous variables). A series of independent means t-tests (continuous variables) and chi-square tests (categorical variables) were conducted to examine differences between the analyzed and excluded participants across the focal predictors and outcomes. We did not observe systematic differences between the excluded and analyzed samples (see supplementary table 1).

### Procedure

In each wave, trained interviewers conducted 50–60 minute face-to-face interviews with participants at home or in a community setting. After each interview, participants completed a paper and pencil questionnaire on substance use and sexual behavior to ensure more confidentiality for these questions. Researchers obtained consent from the participants' parent as well as assent from the participant. The retention rates of the original study were generally high (90%) for the first four waves. The university institutional review board approved all study protocols and the study meets the requirements for the protection of human subjects.

### Measures

**Firearm Carriage.**—To assess firearm carriage during Waves 1 to 4, participants were asked, “In the last 12 months, how often have you carried a gun?” Participants responded on a 5-point Likert scale of 0 (*0 times*) to 4 (*4+ times*).

**Exposure to Violence.**—The frequency of violent victimization and violence observation in the past 12 months were averaged to assess violence exposure within each measurement period (i.e., Waves 1 to 4). Participants reported the frequency of violence exposure on a 5-point Likert type scale of 0 (*0 times*) to 5 (*4 or more times*) in the past 12 months.

Specifically, three questions pertained to violent victimization (i.e., “I had someone threaten to hurt me”, “I had something taken from me by physical force”, and “I experienced being physically assaulted or hurt by someone”), while two items assessed violence observation (i.e., “seen someone commit a violence crime where a person was hurt” and “seen someone get shot, stabbed or beaten up”).

**Future Expectations.**—In Waves 1 to 4, two indicators were used to measure the participants’ future expectations about educational outcomes, a critical component when thinking about the future during adolescence: 1) the participant’s belief about how likely he/she was to graduate from high school, and 2) the participant’s belief about how likely he/she was to continue education after high school (e.g. go to trade school/college/4-year University). Participants responded to each item on a 5-point scale ranging from 0 (*not at all likely to*) to 4 (*very likely*). We computed a composite score by taking the mean for the two indicators. Inter-item correlation ranged from .37 to .43 across waves.

**Time Invariant and Varying Covariates.**—In Wave 1, participants self-reported their sex, race, and mother’s educational attainment (i.e. did not graduate high school, graduated high school, or attending/completed higher-education). We also used the Brief Symptom Inventory (Derogatis & Spencer, 1982) from Waves 1 through Wave 4 to assess internalizing symptoms (12 items, Cronbach’s  $\alpha = .84-.91$ ) during the past week. The frequency of alcohol, cigarette, and marijuana use were each assessed during Waves 1 through 4. During each measurement period, participants were asked how frequently they used each substance during the past 30 days on a scale from 0 (*0 times*) to 6 (*40 or more times*). We analyzed internalizing symptoms, alcohol use, cigarette use, and marijuana use as time varying covariates. Lastly, we adjusted for the four high schools from where the participants were recruited by including each school as a nominal predictor (i.e., the fourth high school was the referent group).

### Analytic Approach

All statistical analyses were conducted using Mplus, version 8.2 (Muthén & Muthén, 2019). Descriptive statistics and the inter-correlations between study variables were examined. As an initial step to examining the psychological pathway from exposure to violence to firearm carriage, we fit unconditional latent growth models (LGMs) to characterize within and between-person change for exposure to violence, future expectation, and firearm carriage. In particular, since we are interested in examining associations between latent growth terms, LGMs ascertained variability in the growth terms. Model fit was considered acceptable if the root mean square error of approximation (RMSEA) was equal to or less than .09 (Brown & Cudeck, 1980), comparative fit index (CFI) was greater than 0.90 (Bentler, 1990), and Tucker Lewis (TLI) index was greater than .90 (Tucker & Lewis, 1973). We used a diagonally weighted least square estimation with mean and variance adjustments to estimate the LGM for firearm carriage. WLSMV has been recommended for categorical, non-normal data, as no distributional assumptions are made about the observed variables (*see* Li, 2015). For future expectation and exposure to violence, we used maximum likelihood estimation to estimate the LGMs.



To evaluate the first aim of the study, we fit a parallel process latent growth model (PP-LGM) to evaluate the associations between latent intercepts (i.e., Wave 1) and slopes (rate of change from Waves 1 to 4) for exposure to violence and firearm carriage. We subsequently conducted latent growth mediation model (LGMM; Cheong, MacKinnon, & Khoo, 2003). Specifically, the growth terms (i.e., latent intercept, slope) of future expectations were regressed on the intercept of exposure to violence, while the slope of future expectations was regressed on the slope of exposure to violence. In addition, the growth terms of firearm carriage were regressed on the intercepts of exposure to violence and future expectations, while the slope of firearm carriage was regressed on the slope of future expectations and exposure to violence. After evaluating model fit, indirect effects were examined from the growth terms of exposure to violence to the slope of firearm carriage through the growth terms of future expectations (see Cheong et al., 2003 for a detailed review of LGMM). We controlled for sex, race (i.e., non-White), mother's educational attainment, alcohol use, marijuana use, cigarette use, and internalizing symptoms in the PP-LGM and LGMM. WLSMV estimation, in conjunction with a bootstrapping procedure (1000 bootstraps), were implemented to estimate model coefficients in the PP-LGM and LGMM. Indirect effects were estimated using a bias-corrected bootstrap procedure in the LGMM (i.e., MacKinnon, Lockwood, & Williams, 2004). Missing data was handled for both aims using pairwise deletion if missing on the dependent variable, and listwise deletion if missing on the independent variable.

## Results

### Preliminary Analysis and Unconditional Latent Growth Models

Descriptive statistics for the study variables are reported in Table 1. Of note, the observed mean of exposure to violence gradually decreased from grade 9 to 12, whereas the observed mean of firearm carriage, marijuana use, cigarette use, and alcohol use increased gradually. Further, future expectations, on average, decreased from grade 9 to 12. Moreover, firearm carriage was associated between measurement periods (range or correlation = .32 – .66), with stronger correlations observed between measurement periods closer in time (e.g.,  $t$  and  $t + 1$ ). Furthermore, 101 participants endorsed carrying a firearm during a single measurement period, while 82 participants reported carrying a firearm across multiple measurement periods.

Intercept, slope, and quadratic estimates were initially estimated for unconditional LGMs for exposure to violence, future expectations, and firearm carriage. However, we elected to include only the intercept and slope estimates since the fixed and random effects of the quadratic terms were not significant (see Table 2). The LGM for exposure to violence demonstrated acceptable fit (see Table 2), with variability in the intercept ( $\sigma^2 = .30$ ) and slope term ( $\sigma^2 = .02$ ). The LGM for future expectations also fit the data well (see Table 2), with variability in the intercept ( $\sigma^2 = .15$ ) and slope ( $\sigma^2 = .02$ ). Lastly, variability was observed in the intercept ( $\sigma^2 = .88$ ) and slope term ( $\sigma^2 = .05$ ) for firearm carriage, and the LGM fit the data well (see Table 2).

### **Aim 1: Longitudinal Association between Exposure to Violence and Firearm Carriage**

We tested the first study aim by regressing the latent intercept and slope of firearm carriage on the latent intercept and slope of exposure to violence. The PP-LGM demonstrated satisfactory model fit (see Table 3) and the latent slope of exposure to violence was positively associated with the latent slope of firearm carriage ( $b = 0.77$ ), net the effects of demographic characteristics, internalizing symptoms, future expectations, and substance use indicators. The latent intercept of exposure to violence was positively associated with the latent intercept of firearm carriage ( $b = 0.58$ ), whereas the latent intercept of exposure to violence did not predict the latent slope of firearm carriage.

Several time invariant covariates were associated with the latent growth terms in the PP-LGM (see Table 3). The latent intercept of firearm carriage was positively associated with being male, while the latent slope of firearm carriage was positively associated with identifying as non-White. In addition, as shown in Table 3, exposure to violence (i.e., victimization, observation) in the 9<sup>th</sup> grade was positively associated with being male and non-White. Moreover, differences in violence exposure was observed between participants in high school 2 and high school 4. Lastly, as shown in Table 4, exposure to violence was positively associated with internalizing symptoms and alcohol use, and negatively associated with future expectations at each grade level (i.e., 9<sup>th</sup> to 12<sup>th</sup> grade). Marijuana use was positively associated with exposure to violence after grade 9, and cigarette use was positively associated with exposure to violence after grade 10. With regards to firearm carriage, marijuana use was positively associated with firearm carriage in the 11<sup>th</sup> grade, while cigarette use was associated with firearm carriage at all grade levels except 10<sup>th</sup> grade (see Table 4). Future expectations was negatively associated with firearm carriage in grade 12 and internalizing symptoms was positively associated with firearm carriage in the 9<sup>th</sup> and 10<sup>th</sup> grade.

### **Aim 2: Future Expectations as a Mediator**

To investigate future expectations as a mediator to the longitudinal association between exposure to violence and firearm carriage, we estimated a LGMM that fit the data well (see Table 5). After controlling for demographic factors, internalizing symptoms, and substance use correlates, the LGMM revealed that the latent slope of exposure to violence ( $b = 2.03$ ) and the latent intercept of future expectations ( $b = -0.65$ ) predicted the latent slope of firearm carriage. In addition, the latent intercept of exposure to violence ( $b = 1.39$ ) and the latent intercept of future expectation ( $b = 0.81$ ) predicted the latent intercept of firearm carriage. For future expectations, the latent slope of exposure to violence predicted the latent slope of future expectations ( $b = -0.20$ ), while the latent intercept of exposure to violence predicted the latent intercept of future expectations ( $b = -0.22$ ). To examine whether future expectations mediated the longitudinal association between exposure to violence and firearm violence, we examined three indirect effects (see Table 7). Of the three, we observed an indirect effect from the latent intercept of exposure to violence to the latent slope of firearm carriage through the latent intercept of future expectations ( $b = .15$ ). In particular, exposure to violence was associated with less future expectations in the 9<sup>th</sup> grade, while lower levels of future expectations was associated with a higher rate of change in firearm carriage.



The influence of covariates on the growth terms of exposure to violence, future expectations, and firearm carriage can be found in Table 6. It is noteworthy to mention that the latent intercept of firearm carriage and exposure to violence was associated with being male, whereas the slope of firearm carriage was associated with being Non-White. Moreover, differences between the first and fourth high school was observed for future expectation in the 9<sup>th</sup> grade. Further, many of the time varying covariates were not associated with firearm carriage and future expectations at most grade levels. For instance, internalizing symptoms was negatively associated with future expectations in the 9<sup>th</sup> grade, whereas cigarette use was negatively associated with future expectations in the 10<sup>th</sup> grade. Cigarette use and internalizing symptoms were also positively associated with firearm carriage in the 9<sup>th</sup> and 12<sup>th</sup> grade. Alcohol use, on the other hand, was associated with firearm carriage in the 10<sup>th</sup> grade (see Table 6).

### Sensitivity Analysis

It is plausible that adolescents with higher levels of educational future expectations are also more likely to have a lower risk of exposure to violence, which, in turn, may attenuate the likelihood of firearm carriage over time. We, thus, conducted a sensitivity analysis and examined the effect of future expectation on the slope of firearm carriage through exposure to violence. While the LGMM in the sensitivity analysis fit the data equally well as our original LGMM, pathways from future expectation (i.e., intercept and slope) to the slope of firearm carriage risk (i.e., slope) were not significant.

### Discussion

Public health and criminological researchers have consistently documented the influence of exposure to violence on firearm carriage among youth (Beardslee et al., 2018; Spano & Bolland, 2013). Building on these studies, we examined the longitudinal association between exposure to violence and firearm carriage (aim 1), and future expectation as a mediator to the violence exposure and firearm carriage link (aim 2). Concerning the first study aim, our results suggests that the trajectory of exposure to violence may be associated with the developmental unfolding of firearm carriage during adolescence. These findings support previous researchers (Stoddard et al., 2015) who posit that routine exposure to violence can increase vulnerability for violent behaviors, including firearm carriage. Spano and Bolland (2013), for example, found that violent victimization in the prior year predicted gun carrying after controlling for the participants' gender, history of violent behavior, fear of crime, and gang membership. Youth violence prevention efforts may be an effective strategy for reducing firearm carriage and violence. Crime prevention through environmental design, an evidence-based socio-ecological program, is one such program that can reduce youth assault and injury, which, in turn, may translate to less firearm carriage among youth (Heinze et al., 2016).

We also found that exposure to violence in the 9<sup>th</sup> grade was indirectly associated with the rate of change in firearm carriage through educational future expectations in the 9<sup>th</sup> grade. Exposure to violence was negatively associated with educational future expectations in the 9<sup>th</sup> grade, while educational future expectations was negatively associated with the rate of

change in firearm carriage from the 9<sup>th</sup> to 12<sup>th</sup> grade. In step with the findings from Stoddard and colleagues' study (2015), our results suggest that future expectations play an important role in shaping the association between exposure to violence and firearm carriage. Specifically, we found that exposure to violence predicts lower future educational expectations (Agnew, 1992; Agnew & White, 1992). For many youth, exposure to violence is a traumatic experience (Garrido, Culhane, Raviv, & Taussig, 2010) that can invoke symptoms of trauma (e.g., post-traumatic stress disorder), such as a shortened time horizon (see American Psychiatric Association, 2013). Adolescents victimized by violence may have difficulty envisioning positive future outcomes, which may promote a sense of hopelessness (Bolland et al., 2001; Lambert, Nylund-Gibson, Copeland-Linder, & Ianlongo, 2010) and risk-taking (Albus, Weist, & Perez-Smith, 2004; Berenson, Wiemann, & McCombs, 2001; Bolland, 2003). Adolescents unable to envision a positive future may also engage in violence-related behaviors such as carrying a firearm (Stoddard et al., 2015).

It is noteworthy to mention that the rate of change in future expectations from the 9<sup>th</sup> to 12<sup>th</sup> grade was not associated with developmental progression of firearm carriage. As such, future expectations in the 9<sup>th</sup> grade appears to be particularly important for influencing firearm carriage. Scholars have identified 9<sup>th</sup> grade as a critical developmental period in which adolescents are particularly vulnerable to stress (e.g., stressful life events: Lee & Neblett, 2017) and negative attitudes (e.g., diminished future expectations; Stoddard et al., 2015). Stoddard et al., 2015 found that future educational expectations in the 9<sup>th</sup> grade predicted higher levels of hostility in the 12<sup>th</sup> grade. Thus, our findings suggest that future expectations in the 9<sup>th</sup> grade is associated with the likelihood of firearm carriage later in life.

Although our measure assessed only educational future expectations (e.g., likelihood of graduating high school), future expectations about educational outcomes is associated with non-academic outcomes in late adolescence and emerging adulthood (Beal & Crockett, 2010). While adolescents may have expectations and aspirations across multiple life domains (e.g., career, marriage), educational aspirations were the most frequently mentioned aspirational domain among adolescents (Nurmi, 1987). Researchers have found that adolescents who had higher educational expectations were more likely to smoke fewer cigarettes and exercise more (McDade et al., 2011), endorse less violent attitudes (Stoddard et al., 2015), and consume less alcohol (McWhirter & McWhirter, 2008) than those who had lower educational expectations. In another study, gang-affiliated adolescents were less likely to use substances if they had close friends who were planning to go to college (van Dommelen-Gonzalez, Deardroff, Herd, & Minnis, 2015).

### Limitations and Future Directions

Although this study contributes to our understanding of exposure to violence, future expectations, and firearm carriage in several ways, several limitations require attention. First, our sample consisted of adolescents residing in Flint, Michigan, which has one of the highest rates of violent crime in the United States (e.g., Camden, NJ; Federal Bureau of Investigation, 2016). Therefore, our findings may not generalize to adolescents who reside in suburban or rural settings or contexts that have lower rates of violent crime and higher levels of socio-economic status. Our sample, nevertheless, provides insights into how exposure to

violence may influence firearm carriage for youth who develop in contexts marked by high rates of violent crimes.

Second, our data were collected between 1994 and 1998 and our results may be time bound. It is noteworthy, however, that rates of violent crime and assault in Flint have consistently ranged from 1–2% each year from 1994 to 2014 (Federal Bureau of Investigation, 2018). Thus, it is plausible that adolescents living in Flint, in 1994 and 2014, have been exposed to similar levels of violence. Moreover, more recent longitudinal data examining exposure to violence, firearm carriage, and future expectations is virtually nonexistent. While our study lays the foundation for research on exposure to violence, future expectations, and firearm carriage, more recent longitudinal research would be useful. Notably, it is plausible that our hypotheses about the role of future expectations in the exposure to violence-firearm carriage link would not be different with more current data. We would nonetheless postulate that future expectations would be a significant factor for positive youth development as it relates to firearm outcomes with data collected more recently.

Third, our measure of future expectations included only two items about educational outcomes. While future educational expectations are particularly relevant during adolescence (Nurmi, 1987), utilizing a multidimensional measure of future expectations (e.g., career, family) may be useful for future research. A multidimensional assessment of future expectations may allow researchers to investigate the role of future expectations on firearm carriage in a more nuanced and comprehensive way. Yet, we did find support for hypothesized associations over time even with this limited measurement, which suggests the effects may be especially robust. Fourth, in addition to future expectation, other psychological, social, and ecological factors may influence the longitudinal association between exposure to violence and firearm carriage. Retaliatory attitudes, a psychological factor associated with firearm carriage (Carter et al., 2013), may be an intermediary pathway bridging exposure to violence and firearm carriage among youth. Testing multiple mechanisms will facilitate the development of a multi-component, evidence-based prevention program to reduce youth firearm carriage and violence.

Fifth, while we examined trajectories of exposure to violence, future expectations, and firearm carriage, we did not account for exposure to violence earlier in life (e.g., early childhood). Researchers have reported that childhood violence exposure can increase the likelihood of violent behaviors in late adolescence (e.g., Weaver, Borkowski, & Whitman, 2008). It is, therefore, important for future research to examine how childhood violence exposure influences the longitudinal connections between violence exposure and firearm carriage during adolescence. Sixth, while exposure to violence influences the developmental trajectory of firearm carriage risk during adolescence, it is also plausible that firearm carriage may occur more sporadically or episodically. Thus, to build upon our results, it is vital that researchers leverage dynamic longitudinal data (e.g., diary data) to accurately predict firearm carriage among youth after accounting for episodic and sporadic patterns. Lastly, our results reveal that the risk of firearm carriage from grades 9 to 12 is elevated for males relative to females. To this end, it is crucial that researchers examine sex variant pathways connecting risk factors such as exposure to violence to firearm carriage to identify sex-specific points of intervention for reducing youth firearm carriage.

## Conclusion

Our study advances our understanding of exposure to violence and firearm carriage in two important ways. First, we demonstrate that increasing the rate of change in exposure to violence can increase the likelihood of firearm carriage over time (i.e., 9<sup>th</sup> to 12<sup>th</sup> grade). Apart from a few longitudinal studies (e.g., Spano & Bolland, 2013), the preponderance of research on exposure to violence and future expectations have utilized cross-sectional data. Our study is the first, to our knowledge, to investigate how changes in exposure to violence influences the way firearm carriage risk unfolds over time. We also found that higher levels of exposure to violence were associated with less future expectations in the 9<sup>th</sup> grade, and that lower levels of future expectations in the 9<sup>th</sup> grade increased the rate of change in firearm carriage from the 9<sup>th</sup> to 12<sup>th</sup> grade. Our research offers a beginning point for identifying psychosocial pathways that connect exposure to violence to firearm carriage. Building on this program of research will provide important insights for designing prevention strategies for firearm violence, especially for youth exposed to violence. Our results support the idea that helping youth develop positive attitudes about educational success may help reduce firearm carriage.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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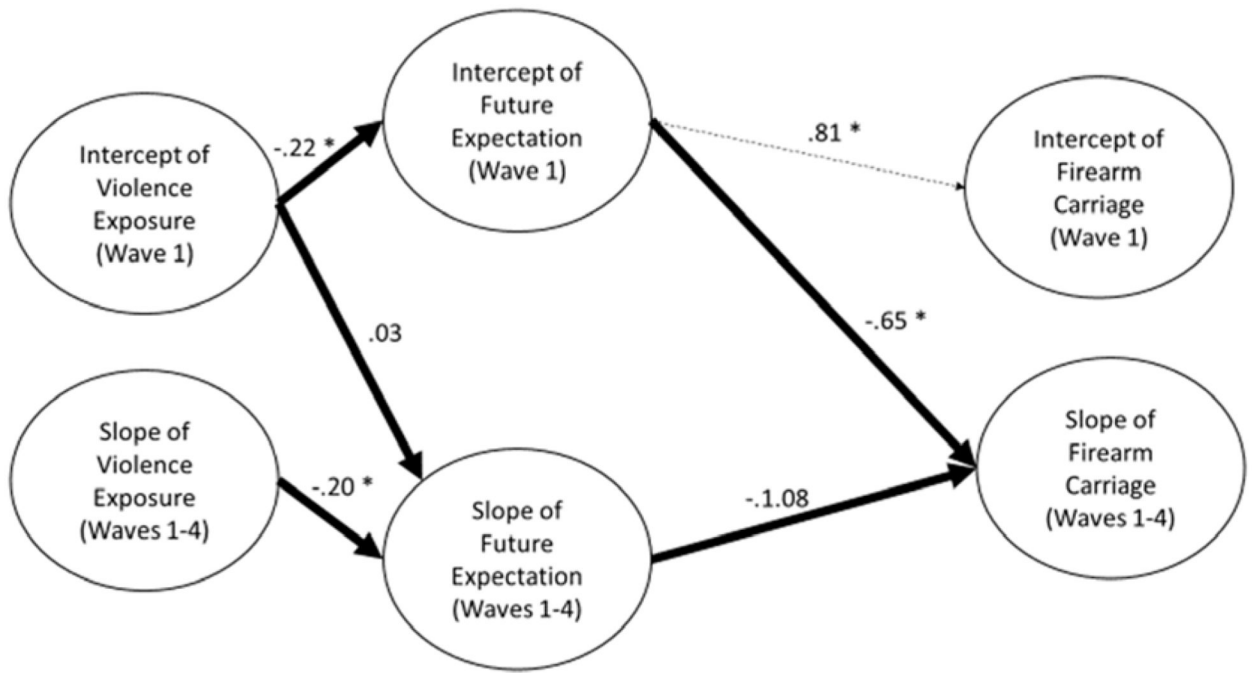
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**Figure 1.** Latent growth mediation model from exposure to violence to firearm carriage through future expectation. Bolded lines correspond to hypothesized pathways and asterisks correspond to significant coefficients. Coefficients are unstandardized.

**Table 1**

## Descriptive Statistics

| Study Variables                     | M (SD) or %   |
|-------------------------------------|---------------|
| Male                                | 50% Males     |
| Non-White                           | 80% Non-White |
| Mother's Education                  | 4.35 (1.88)   |
| Marijuana Use (9th grade)           | 0.96 (1.67)   |
| Marijuana Use (10th grade)          | 1.57 (2.07)   |
| Marijuana Use (11th grade)          | 1.64 (2.19)   |
| Marijuana Use (12th grade)          | 1.74 (2.27)   |
| Alcohol Use (9th grade)             | 1.01 (1.46)   |
| Alcohol Use (10th grade)            | 1.24 (1.57)   |
| Alcohol Use (11th grade)            | 1.33 (1.77)   |
| Alcohol Use (12th grade)            | 1.56 (1.80)   |
| Cigarette Use (9th grade)           | 0.43 (0.89)   |
| Cigarette Use (10th grade)          | 0.57 (1.11)   |
| Cigarette Use (11th grade)          | 0.68 (1.25)   |
| Cigarette Use (12th grade)          | 0.86 (1.43)   |
| Internalizing Symptoms (9th grade)  | 0.63 (0.61)   |
| Internalizing Symptoms (10th grade) | 0.80 (0.81)   |
| Internalizing Symptoms (11th grade) | 0.74 (0.76)   |
| Internalizing Symptoms (12th grade) | 0.73 (0.84)   |
| Exposure to Violence (9th grade)    | 0.84 (0.74)   |
| Exposure to Violence (10th grade)   | 0.76 (0.75)   |
| Exposure to Violence (11th grade)   | 0.62 (0.69)   |
| Exposure to Violence (12th grade)   | 0.52 (0.65)   |
| Future Expectation (9th grade)      | 4.39 (0.57)   |
| Future Expectation (10th grade)     | 4.22 (0.56)   |
| Future Expectation (11th grade)     | 4.23 (0.53)   |
| Future Expectation (12th grade)     | 4.16 (0.67)   |
| Firearm Carriage (9th grade)        | 0.18 (0.71)   |
| Firearm Carriage (10th grade)       | 0.21 (0.73)   |
| Firearm Carriage (11th grade)       | 0.25 (0.83)   |
| Firearm Carriage (12th grade)       | 0.25 (0.83)   |

**Table 2**

Unconditional Latent Growth Models with Intercept and Slope Terms (waves 1 to 4)

|                    | $\chi^2$ (df) | RMSEA | CFI | TLI | Intercept | Slope   | Var(Intercept) | Var(Slope) |
|--------------------|---------------|-------|-----|-----|-----------|---------|----------------|------------|
| Violence Exposure  | 8.92 (5)      | .03   | .99 | .99 | 0.85 *    | -0.11 * | 0.30 *         | 0.02 *     |
| Future Expectation | 28.90 (5) *   | .07   | .96 | .95 | 4.35 *    | -0.07 * | 0.15 *         | 0.02 *     |
| Firearm Carriage   | 44.27 (11) *  | .06   | .98 | .99 | --        | 0.05    | 0.88 *         | 0.05 *     |

Note.

\* is  $p < .01$ .

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**Table 3**

PP-LGM between Exposure to Violence and Firearm Carriage

|                                 | <i>b</i> | 95% Bootstrap C.I. | $\beta$ |
|---------------------------------|----------|--------------------|---------|
| Slope of Firearm Carriage       |          |                    |         |
| Intercept of Violence Exposure  | .02      | -.09, .12          | .05     |
| Slope of Violence Exposure      | .77      | .45, 1.33          | .79     |
| Male                            | .004     | -.04, .06          | .02     |
| Non-White                       | .07      | .01, .14           | .21     |
| Mother Educational Attainment   | -.002    | -.01, .01          | -.03    |
| School 1                        | .02      | -.04, .08          | .05     |
| School 2                        | .03      | -.03, .09          | .08     |
| School 3                        | .03      | -.04, .12          | .09     |
| Intercept of Firearm Carriage   |          |                    |         |
| Intercept of Violence Exposure  | .58      | .37, .84           | .56     |
| Male                            | .12      | .04, .21           | .13     |
| Non-White                       | -.01     | -.13, .11          | -.01    |
| Mother's Educational Attainment | .001     | -.03, .03          | .01     |
| School 1                        | .07      | -.06, .19          | .07     |
| School 2                        | -.04     | -.18, .10          | -.04    |
| School 3                        | .01      | -.13, .14          | .01     |
| Slope of Violence Exposure      |          |                    |         |
| Male                            | -.01     | -.05, .03          | -.03    |
| Non-White                       | .02      | -.04, .07          | .05     |
| Mother's Educational Attainment | -.01     | -.02, .001         | -.11    |
| School 1                        | -.02     | -.07, .03          | -.06    |
| School 2                        | -.05     | -.11, .01          | -.14    |
| School 3                        | -.06     | -.12, .00          | -.15    |
| Intercept of Violence Exposure  |          |                    |         |
| Male                            | .23      | .13, .32           | .25     |
| Non-White                       | .15      | .03, .27           | .14     |
| Mother's Educational Attainment | .02      | -.01, .04          | .07     |
| School 1                        | .02      | -.10, .15          | .02     |
| School 2                        | .15      | .01, .30           | .14     |
| School 3                        | .10      | -.04, .24          | .08     |

Note. Model fit:  $\chi^2(167) = 341.00, p < .01, RMSEA = .04, CFI = .91, TLI = .88.$   $\beta$  = standardized estimate.

**Table 4**

## PP-LGM Time Varying Covariates

|                                          | <i>b</i> | $\beta$ |                                      | <i>b</i> | $\beta$ |
|------------------------------------------|----------|---------|--------------------------------------|----------|---------|
| <b>Exposure to Violence (9th grade)</b>  |          |         | <b>Firearm Carriage (9th grade)</b>  |          |         |
| Internalizing Symptoms (9th grade)       | .33*     | .25*    | Internalizing Symptoms (9th grade)   | .12*     | .10*    |
| Marijuana Use (9th grade)                | .03      | .06     | Marijuana Use (9th grade)            | -.02     | -.04    |
| Alcohol Use (9th grade)                  | .07*     | .13*    | Alcohol Use (9th grade)              | .08*     | .16*    |
| Cigarette Use (9th grade)                | .06      | .06     | Cigarette Use (9th grade)            | .17*     | .20*    |
| Future Expectations (9th grade)          | -.13*    | -.10*   | Future Expectations (9th grade)      | .07      | .06     |
| <b>Exposure to Violence (10th grade)</b> |          |         | <b>Firearm Carriage (10th grade)</b> |          |         |
| Internalizing Symptoms (10th grade)      | .13*     | .15*    | Internalizing Symptoms (10th grade)  | .05*     | .07*    |
| Marijuana Use (10th grade)               | .07*     | .19*    | Marijuana Use (10th grade)           | .02      | .06     |
| Alcohol Use (10th grade)                 | .05*     | .10*    | Alcohol Use (10th grade)             | .05*     | .12*    |
| Cigarette Use (10th grade)               | .01      | .02     | Cigarette Use (10th grade)           | .03      | .05     |
| Future Expectations (10th grade)         | -.10*    | -.08*   | Future Expectations (10th grade)     | .02      | .02     |
| <b>Exposure to Violence (11th grade)</b> |          |         | <b>Firearm Carriage (11th grade)</b> |          |         |
| Internalizing Symptoms (11th grade)      | .11*     | .12*    | Internalizing Symptoms (11th grade)  | .02      | .02     |
| Marijuana Use (11th grade)               | .04*     | .14*    | Marijuana Use (11th grade)           | .06*     | .17*    |
| Alcohol Use (11th grade)                 | .06*     | .16*    | Alcohol Use (11th grade)             | .03      | .07     |
| Cigarette Use (11th grade)               | .05*     | .10*    | Cigarette Use (11th grade)           | .07*     | .12*    |
| Future Expectations (11th grade)         | -.08*    | -.07*   | Future Expectations (11th grade)     | -.05     | -.04    |
| <b>Exposure to Violence (12th grade)</b> |          |         | <b>Firearm Carriage (12th grade)</b> |          |         |
| Internalizing Symptoms (12th grade)      | .05*     | .07*    | Internalizing Symptoms (12th grade)  | .04      | .04     |
| Marijuana Use (12th grade)               | .03*     | .10*    | Marijuana Use (12th grade)           | .02      | .06     |
| Alcohol Use (12th grade)                 | .07*     | .20*    | Alcohol Use (12th grade)             | .06*     | .13*    |
| Cigarette Use (12th grade)               | .06*     | .14*    | Cigarette Use (12th grade)           | .07*     | .11*    |
| Future Expectations (12th grade)         | -.07*    | -.07*   | Future Expectations (12th grade)     | -.13*    | -.10*   |

Note.

\* is statistically significant according to the bootstrap 95% confidence interval.



**Table 5**

## Latent Growth Mediation Model

|                                   | <i>b</i> | <i>95% Bootstrap C.I.</i> | $\beta$ |
|-----------------------------------|----------|---------------------------|---------|
| Slope of Firearm Carriage         |          |                           |         |
| Intercept of Exposure to Violence | -0.38    | -0.36, 2.58               | 0.27    |
| Slope of Exposure to Violence     | 2.03     | 0.53, 7.06                | 0.51    |
| Intercept of Future Expectations  | -0.65    | -1.70, -0.18              | -0.39   |
| Slope of Future Expectations      | -1.08    | -5.14, 0.13               | -0.19   |
| Male                              | 0.12     | -0.22, 1.34               | 0.10    |
| Non-White                         | 0.073    | 0.09, 2.00                | 0.49    |
| Mother Educational Attainment     | -0.08    | -0.20, 0.03               | -0.22   |
| School 1                          | -0.07    | -0.71, 0.28               | -0.05   |
| School 2                          | -0.26    | -0.97, 0.09               | -0.18   |
| School 3                          | -0.27    | -1.14, 0.14               | -0.16   |
| Intercept of Firearm Carriage     |          |                           |         |
| Intercept of Exposure to Violence | 1.39     | 0.77, 1.83                | 0.58    |
| Intercept of Future Expectations  | 0.81     | 0.23, 1.41                | 0.29    |
| Male                              | 1.09     | 0.43, 1.86                | 0.51    |
| Non-White                         | 0.02     | -0.70, 0.63               | 0.01    |
| Mother's Educational Attainment   | 0.10     | -0.04, 0.23               | 0.18    |
| School 1                          | 0.28     | -0.32, 1.15               | 0.12    |
| School 2                          | 0.33     | -0.30, 1.01               | 0.13    |
| School 3                          | 0.26     | -0.53, 1.05               | 0.09    |
| Slope of Future Expectations      |          |                           |         |
| Intercept of Exposure to Violence | 0.03     | -0.02, 0.09               | 0.13    |
| Slope of Exposure to Violence     | -0.20    | -0.38, -0.04              | -0.29   |
| Male                              | -0.02    | -0.06, 0.01               | -0.09   |
| Non-White                         | 0.05     | 0.01, 0.10                | 0.20    |
| Mother Educational Attainment     | 0.002    | -0.01, 0.01               | 0.03    |
| School 1                          | 0.02     | -0.03, 0.06               | 0.09    |
| School 2                          | -0.01    | -0.05, 0.04               | -0.02   |
| School 3                          | -0.02    | -0.07, 0.03               | -0.07   |
| Intercept of Future Expectations  |          |                           |         |
| Intercept of Exposure to Violence | -0.22    | -0.38, -0.11              | -0.26   |
| Male                              | -0.10    | -0.19, -0.01              | -0.14   |
| Non-White                         | 0.04     | -.06, 0.15                | 0.04    |
| Mother's Educational Attainment   | -0.01    | -0.03, 0.01               | -0.06   |
| School 1                          | -0.11    | -0.22, -0.01              | -0.13   |
| School 2                          | -0.003   | -0.11, 0.10               | -0.003  |
| School 3                          | -0.06    | -0.18, 0.06               | -0.06   |

Note. Model fit:  $\chi^2(252) = 349.12, p < .01, RMSEA = .03, CFI = .93, TLI = .91$ .  $\beta$  = standardized estimate.

**Table 6**

## Latent Growth Mediation Model - Time Varying Covariates

| <b>9th Grade</b>            |      | <i>b</i> | $\beta$                    |       |       | <i>b</i>                | $\beta$ |      |  | <i>b</i> | $\beta$ |
|-----------------------------|------|----------|----------------------------|-------|-------|-------------------------|---------|------|--|----------|---------|
| <b>Exposure to Violence</b> |      |          | <b>Future Expectations</b> |       |       | <b>Firearm Carriage</b> |         |      |  |          |         |
| Internalizing Symptoms      | .42* | .33*     | Internalizing Symptoms     | -.12* | -.14* | Internalizing Symptoms  | .48*    | .22* |  |          |         |
| Marijuana Use               | .03  | .07      | Marijuana Use              | -.01  | -.02  | Marijuana Use           | .04     | .05  |  |          |         |
| Alcohol Use                 | .08* | .15*     | Alcohol Use                | .002  | .01   | Alcohol Use             | .20     | .22  |  |          |         |
| Cigarette Use               | .05  | .05      | Cigarette Use              | -.05  | -.02  | Cigarette Use           | .38*    | .23* |  |          |         |
| <b>10th Grade</b>           |      | <i>b</i> | $\beta$                    |       |       | <i>b</i>                | $\beta$ |      |  | <i>B</i> | $\beta$ |
| <b>Exposure to Violence</b> |      |          | <b>Future Expectations</b> |       |       | <b>Firearm Carriage</b> |         |      |  |          |         |
| Internalizing Symptoms      | .09* | .11*     | Internalizing Symptoms     | -.03  | -.04  | Internalizing Symptoms  | .20     | .11  |  |          |         |
| Marijuana Use               | .08* | .23*     | Marijuana Use              | -.03  | -.10  | Marijuana Use           | .07     | .09  |  |          |         |
| Alcohol Use                 | .04  | .09      | Alcohol Use                | -.01  | -.04  | Alcohol Use             | .18*    | .19* |  |          |         |
| Cigarette Use               | .01  | .02      | Cigarette Use              | -.08* | -.16* | Cigarette Use           | -.12    | -.09 |  |          |         |
| <b>11th Grade</b>           |      | <i>b</i> | $\beta$                    |       |       | <i>B</i>                | $\beta$ |      |  | <i>B</i> | $\beta$ |
| <b>Exposure to Violence</b> |      |          | <b>Future Expectations</b> |       |       | <b>Firearm Carriage</b> |         |      |  |          |         |
| Internalizing Symptoms      | .09* | .12*     | Internalizing Symptoms     | -.02  | -.02  | Internalizing Symptoms  | .15     | .06  |  |          |         |
| Marijuana Use               | .04  | .12      | Marijuana Use              | -.02  | -.07  | Marijuana Use           | .15     | .16  |  |          |         |
| Alcohol Use                 | .06* | .17*     | Alcohol Use                | -.02  | -.05  | Alcohol Use             | .02     | .02  |  |          |         |
| Cigarette Use               | .02  | .04      | Cigarette Use              | -.04  | -.09  | Cigarette Use           | .08     | .05  |  |          |         |
| <b>12th Grade</b>           |      | <i>b</i> | $\beta$                    |       |       | <i>b</i>                | $\beta$ |      |  | <i>b</i> | $\beta$ |
| <b>Exposure to Violence</b> |      |          | <b>Future Expectations</b> |       |       | <b>Firearm Carriage</b> |         |      |  |          |         |
| Internalizing Symptoms      | .05  | .07      | Internalizing Symptoms     | .03   | .05   | Internalizing Symptoms  | .49*    | .14* |  |          |         |
| Marijuana Use               | .03  | .10      | Marijuana Use              | .02   | .08   | Marijuana Use           | .08     | .06  |  |          |         |
| Alcohol Use                 | .06* | .19*     | Alcohol Use                | -.03  | -.08  | Alcohol Use             | .24*    | .14* |  |          |         |
| Cigarette Use               | .08* | .19*     | Cigarette Use              | -.002 | -.004 | Cigarette Use           | .51*    | .24* |  |          |         |

Note.

\* is statistically significant according to the bootstrap 95% confidence interval.

**Table 7**

## Latent Growth Mediation Model - Indirect Effects

| <b>Longitudinal Pathways</b>                                                                                       | <i>b</i> | <i>Bias Corrected 95% CI</i> | <i>Indirect Effect / Total Effect</i> | $\beta$ |
|--------------------------------------------------------------------------------------------------------------------|----------|------------------------------|---------------------------------------|---------|
| Exposure to Violence (9th grade) → Future Expectation (9th grade) → Firearm Carriage (A9th-12th grade)             | .15      | .04, .44                     | 30.61%                                | 0.1*    |
| Exposure to Violence (9th grade) → Future Expectation (A9th-12th grade) → Firearm Carriage (A9th-12th grade)       | -.04     | -.34, .004                   | N/A                                   | -0.03   |
| Exposure to Violence (A9th-12th grade) → Future Expectation (A9th-12th grade) → Firearm Carriage (A9th-12th grade) | .22      | -.01, 1.48                   | 9.60%                                 | 0.05    |

*Note.* N/A = proportion of indirect and total effect is not meaningful because the indirect effect is negative.  $\beta$  = standardized coefficient.