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Risk and protective factors related to youth firearm violence: a scoping review and directions for future research

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Abstract To conduct our scoping review of risk and protective factors for firearm violence among youth, we searched PubMed, Scopus, EMBASE, and Criminal Justice Abstracts for English-language research articles published between January 1985 and May 2018. We included studies of modifiable risk or protective factors associated with intentional (including suicide) or unintentional firearm victimization or perpetration with samples that included youth $\leq$ 17. Among the 28 included studies, 15 explored risk/protective factors for victimization, five focused on perpetration, five did not differentiate between victimization and perpetration, and five focused on suicide. Most studies examined individual-level risk factors. The few that explored factors beyond the individual were limited by methodological weaknesses and inconsistent findings. Protective factors for youth firearm outcomes were understudied. We need more research on youth firearm violence using longitudinal data and robust statistical methods. Future research is needed to understand the underlying mechanisms by which risk/protective factors influence firearm violence.

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Introduction

Firearm violence is a significant contributor of morbidity and mortality among children and adolescents. Firearms are the second leading cause of death among youth and adolescents in the U.S. (Cunningham et al., 2018), with 2549 young people ages 0–19 killed by firearms in 2014 (CDC, 2015). Over 70% of injuries from firearm violence among youth result from homicides or assault, though unintentional injuries (18.7%) and self-inflicted injuries and suicide (7.8%) are also significant contributors (CDC, 2015). Yet research on firearm violence is limited due to persistent restrictions on funding for research (Carter & Cunningham, 2016). While research on risk and protective factors for adolescent suicide and youth violence in general is ubiquitous, we have a paucity of research on the risk and protective factors associated specifically with youth firearm violence. In particular, little is known about risk and protective factors for intentional and unintentional firearm victimization and perpetration, and suicide by firearms among children and adolescents.

Identifying risk and protective factors for youth firearm violence is a vital first step to developing and implementing effective, tailored prevention efforts (Hawkins et al., 2002; Herrenkohl et al., 2000; Pollard et al., 1999). Risk factors are features of an adolescent and their environment that increase the likelihood of engaging in firearm violence, while protective factors decrease the likelihood of engaging in firearm violence or reduce the negative effects of risks for firearm violence (Kim et al., 2015). Reducing risk factors and enhancing protective factors are key compo-

nents of a public health approach that has shown promise for preventing negative outcomes among youth (Hawkins et al., 2002; Herrenkohl et al., 2000; Kim et al., 2015).

The Ecological Systems Theory (EST) posits that factors across different levels interact and influence adolescents' behavior and outcomes, and the levels that most directly influence youth include the individual-, family-, peer-, school-, and community-levels (Bronfenbrenner, 1979). Thus, in order to understand risk and protective factors associated with youth firearm violence, we need to study factors across all of these levels. For the purpose of this paper, individual-level risk and protective factors are those that correspond to characteristics specific to an individual such as cognitions, emotions, beliefs, attitudes, and behavior (e.g., mental health problems, academic achievement). Family-level factors are those that involve characteristics of the family structure, home environment, and relationships with family members (e.g., parental support, family conflict, presence of firearms in the home). Peer-level factors include social interactions between youth and their friends and other peers (e.g., involvement with delinquent peers, peer support). School-level factors are those that characterize the physical and social contexts of an individual's school (e.g., school safety, relationships with school personnel). Finally, community-level factors include the physical and social characteristics of youths' neighborhoods (e.g., socioeconomic characteristics, physical conditions of neighborhoods, community social capital).

The purpose of this scoping review is to examine existing research on the modifiable risk and protective factors for youth firearm violence, identify gaps in our knowledge, and prioritize steps for future research. We focused on three firearm-related outcomes: (1) intentional and unintentional firearm violence victimization (e.g., having been shot by a firearm, or having been threatened with a firearm), (2) intentional and unintentional firearm violence perpetration (e.g., having shot someone with a firearm, having threatened someone with a firearm), and (3) suicide by firearm.

Method

Our method for conducting this scoping review was informed by Arksey and O'Malley's (2005) framework and was conducted in three stages. First, we searched for articles from several sources. Second, we developed inclusion and exclusion criteria to identify relevant studies. Finally, we abstracted data from the studies that were deemed relevant to allow us to collate, summarize, and report the results.

Search strategy

We collaborated with an informationist at the University of Michigan Taubman Health Sciences library to complete this scoping review. Systematic searches for original research articles were constructed for each of the following databases: PubMed, Scopus, EMBASE and Criminal Justice Abstracts. We used standard and reproducible searches of free text terms contained within title and abstracts (tiab) and Medical Subject Headings (MeSH terms). Search terms included variations of the following words: firearm, injury, adolescent, risk factor, and protective factor. These terms were organized into Boolean search algorithms submitted to each database. An initial search was created in PubMed and searches in the other databases were translations of that original search (See "Appendix for full PubMed search strategy"). The searches were limited to English language articles. Furthermore, we restricted our search to articles published between January 1985 and May 2018. This timeframe was selected for two reasons. First, we wanted to capture research conducted when firearm violence peaked in the U.S., which was between the late 1980's through the early 1990's (Cohn et al., 2013). Second, due to restrictions on funding for firearm violence research (Carter & Cunningham, 2016), very few studies on this topic have been conducted. As a result, we needed to use a wide range of dates in order to capture as many studies as possible.

Inclusion/exclusion criteria

Study abstracts were included if they reported empirically-based studies of intentional or unintentional firearm victimization, perpetration or suicide outcomes for children and youth participants ages 0–17. Our focus on youth between the ages of 0 and 17 was due to the fact that many contexts relevant to firearm violence are different for youth under age 18 compared to older youth. For example, youth under age 18 have different rights for firearm ownership and carriage compared to youth over the age of 18 years. However, it is important to note that we also included studies that focused on individuals older than 17 as long as their sample included youth under 18 years old. Additionally, we excluded studies that focused on firearm carriage as the outcome. Studies included were required to examine at least one risk or protective factor at any ecological level (i.e., individual, peer, family, school, or community) as a predictor of child firearm violence victimization, perpetration, or suicide by firearm. We excluded articles that examined only non-modifiable characteristics (e.g., age, race, time of day) as predictors of firearm outcomes. Studies that included both modifiable and non-modifiable risk and protective factors were

included. Additionally, our scoping review was inclusive of all study designs, regardless of rigor. We excluded non-empirical commentaries, systematic reviews, meta-analyses, and abstracts/conference papers, and studies focused exclusively on contexts outside the U.S.

Article selection process

Two independent reviewers used Rayyan version 5 (Ouzzani et al., 2016) to screen the title and abstracts of all the articles identified in our literature search to determine whether they met our inclusion/exclusion criteria. In cases where insufficient information was available in the title and abstract, we conducted a full-text review to screen the study. The full-text of all articles that were deemed eligible through our title and abstract review were further assessed for eligibility by two independent reviewers. Additionally, systematic review articles that were identified in our literature search were set aside for reference searching. All citations from these review papers were imported into Rayyan and two reviewers completed a second title and abstract review of these citations to identify further eligible articles not captured in our original searches. Any discrepancies throughout our article selection process were resolved by a third reviewer.

Data abstraction

Three reviewers independently abstracted data from articles included in our scoping review into a form that included the following variables: authors and date of study, study design, sample and setting, firearm outcome and measure, risk and protective factors studied, ecological levels examined, and relevant results. Each reviewer was provided with a guide to help classify study designs and ecological levels. Discrepancies were resolved by consensus.

Methodological quality assessment

Three independent reviewers assessed the methodological quality of each study using an adapted version of the *Guide to Community Preventive Services: Systematic Reviews and Evidence-Based Methods* scoring tool (Zaza et al., 2000). Methodological quality was characterized based on two assessments: (1) the strength of study design, and (2) the quality of study execution. Each reviewer classified the strength of each study's design as one of the following: *greatest*, *moderate*, or *least*. Studies that implemented a prospective cohort design were classified as having the '*greatest*' strength. Studies that implemented a retrospective cohort or a case–control design were classified as '*moderate*' strength, while studies using a cross-sectional design were classified as having the '*least*' strength.

To evaluate the quality of study execution, each reviewer answered 14 items assessing study description (e.g., "Was the study population well described?"), sampling (e.g., "Was the population that served as the unit of analysis the entire eligible population or a probability sample at the point of observation?"), measurement (e.g., "Did the authors use valid/reliable measures to assess the predictor and outcome variables?"), data analysis (e.g., "Did the authors use a model designed to handle multilevel data when they included group-level and individual-level variables in the model?"), and interpretation of results (e.g., "Considering the study design, were appropriate methods for controlling confounding variables and limiting potential biases used?"). For assessing measurement, we determined whether a study used valid measures based on whether the authors reported one or more of the following: measurement of variable in different ways (e.g., consistency checks for self-reports), citations or discussion as to why the use of a measure was valid (e.g., evidence from similar studies). Reliability of measures was assessed based on whether the authors reported one or more of the following: measures of internal consistency (e.g., Cronbach's alpha), measurement of variable in different ways, inter-rater reliability checks (e.g., percent agreement), citations or discussion as to why the use of a measure was reliable. Response options for each question included '*yes*', '*no*, or '*not applicable*'. These items were used to identify the number of threats to the validity of each study. Studies with 0–1 threats to validity were scored as '*good*', 2–4 as '*fair*', and 5 or more as '*limited*'. Each reviewer scored each study independently, and discrepancies were resolved by consensus.

Results

Article identification and selection

Our initial systematic search yielded 821 articles. After eliminating 50 duplicates and including 57 additional studies identified by experts in the field, a total of 828 articles were assessed for eligibility through title and abstract review. Our title and abstract review yielded 82 eligible articles, which subsequently underwent a full-text review. Following the full-text review, we excluded 54 articles that did not meet our inclusion criteria for various reasons (see Fig. 1). We did not identify any further articles for inclusion through our reference searching of review articles. Thus, a total of 28 articles met all inclusion criteria and were included in our scoping review.

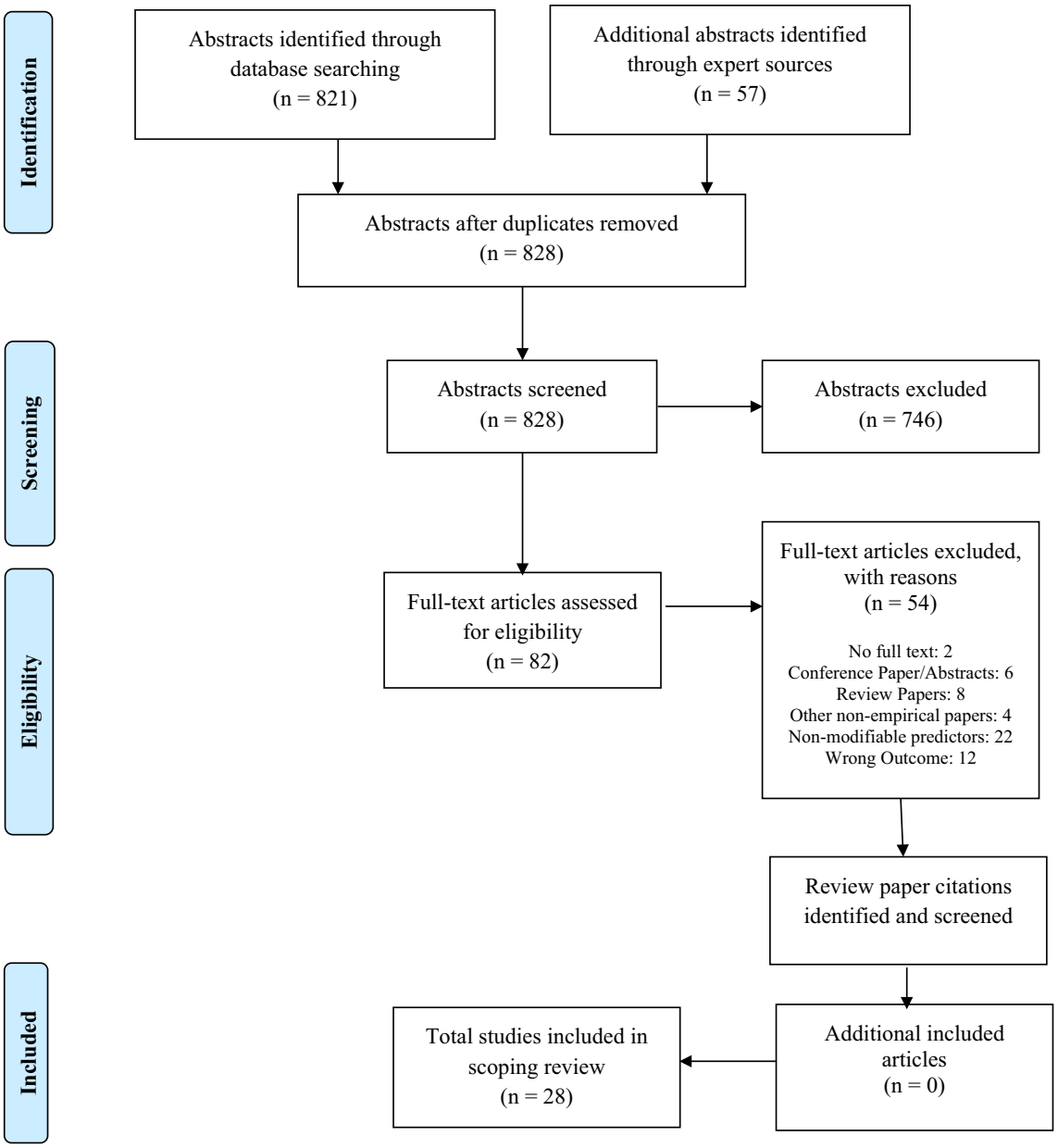

Fig. 1 PRISMA flow diagram

Methodological quality of studies

Of the 28 studies examined, five studies were classified as having the '*greatest*' strength for their use of rigorous, prospective cohort designs. Eight studies were classified as '*moderate*' strength for their application of retrospective cohort, case control or case-crossover designs. The remaining 15 studies were classified as having the '*least*' greatest strength for their use of less rigorous cross-sectional study designs.

We assessed eight studies to have '*good*' study execution quality, 18 studies were scored as '*fair*', and two were scored as '*limited*'. We observed the greatest number of threats to validity across studies in the areas of sampling, measurement, and data analytic approach. For sampling, we observed that 21 studies used non-probability samples. Notably, only four studies used nationally representative samples. Furthermore, 10 studies had issues with selection bias due to participation rates below 80% or significant differences between cases and controls. For measurement, 10 studies included the use of unreliable measures and eight studies used measures that were not valid. With regard to data analysis, 10 studies did not use a model

designed to handle multi-level data when they included group-level and individual covariates in the model.

Main findings

We categorized the 28 included studies according to the type of youth firearm violence outcome studied: firearm violence in general (18%, n = 5), firearm violence victimization (54%, n = 15), firearm violence perpetration (18%, n = 5), and suicide by firearm (18%, n = 5). Our general firearm violence category included studies that defined their outcome by combining the experience of firearm violence victimization and perpetration. More specifically, these studies (compared to studies included in our firearm violence victimization and firearm violence perpetration categories) did not distinguish between individuals who had perpetrated firearm violence, those who had been victimized by firearm violence, and those who had both perpetrated and been victimized by firearm violence. As such, risk/protective factors were not assessed independently for victimization and perpetration, and therefore we classified these studies as *general firearm violence* to reflect the more generalized approach of defining and measuring firearm violence. One study examined risk and protective factors for firearm violence victimization and perpetration separately and, therefore, relevant findings from this study were discussed in both categories. Also, one study examined risk/protective factors for firearm violence victimization and suicide separately so we included this study in both categories. Table 1 provides a summary of the reviewed studies including study design, sample and study setting, type of firearm outcome, risk and protective factors examined, ecological levels assessed, and relevant findings.

General firearm violence

Of the five studies focused on general firearm violence, four were quantitative (i.e., Carter et al., 2015, 2017a, b; Goldstick et al., 2017) and one used a mixed-methods design (i.e., Wilkinson et al., 2009). Two of the quantitative studies implemented a prospective cohort design (i.e., Carter et al., 2015; Goldstick et al., 2017), while the other two were cross-sectional (i.e., Carter et al., 2017a, b). Notably, three of the five studies used the same study sample (i.e., Carter et al., 2015, 2017a; Goldstick et al., 2017). Each of the studies examined individual-level factors, two focused on peer-level factors, and two included community-level factors. None of the studies assessed family-level predictors of firearm violence, incorporated protective factors in their analysis, or focused on unintentional firearm violence.

Individual-level factors At the individual-level, researchers examining general firearm violence have identified psychological and behavioral risk factors. Psychological factors such as mental health outcomes and attitudinal beliefs about retaliation were implicated as risk factors for general firearm violence across four studies. For instance, using a prospective cohort design, Carter et al. (2015) found that PTSD and drug use disorders were associated with a higher likelihood of experiencing general firearm violence within 2 years after baseline. In a separate cross-sectional study, however, Carter et al. (2017a) found that drug use disorder and PTSD were not associated with firearm-related conflicts. Attitudes about violence and retaliation may also increase the risk of general firearm violence. Endorsing retaliatory attitudes, in particular, was associated with an increased likelihood of experiencing general firearm violence (Carter et al., 2015). In a separate study by Carter et al. (2017a), 21.3% of adolescents identified retaliation as motivation for being involved in a firearm-related conflict and retaliation was reported as the top reason (among 16 reasons) for firearm violence among peers (Wilkinson et al., 2009).

While the effect of drug use disorder on general firearm violence is inconclusive, substance use and misuse were identified as behavioral risk factors across four studies (Carter et al., 2015, 2017a; Goldstick et al., 2017). Notably, marijuana, alcohol, and illicit drug use, as well as problematic alcohol consumption (e.g., binge drinking, unable to stop drinking) were documented as risk factors of general firearm violence (Carter et al., 2015, 2017a; Goldstick et al., 2017). Prior involvement in violent events was also identified as a risk factor for general firearm violence. For instance, Goldstick et al. (2017) found that being violently victimized and getting into serious fights was predictive of future engagement in firearm violence.

Peer-level factors Findings from two studies signaled the significance of the peer context for general firearm violence among youth. Using a mixed-methods design, Wilkinson et al. (2009) found that 95.3% of youth involved in violence reported that their friends possessed a firearm, 64.5% reported that their peers carried a firearm for self-protection, and 79% reported that their peers used firearms to commit a crime. Moreover, peer possession was associated with adolescents' firearm possession, and adolescents' firearm possession was associated with co-offending with peers in firearm-related events (Wilkinson et al., 2009). Quantitative studies corroborate these findings (Goldstick et al., 2017).

Table 1 Summary of reviewed studies on youth firearm violence

Azrael et al. (2004)	Retrospective cross-sectional	153 youth aged 0–17 that had committed suicide in Arizona between June 1994 and December 1999	Suicide by firearm	Risk: life crisis, suicidal thoughts, mental health problems, runaway behavior, recent suicide of family member/friend, chronic medical problems, substance use, CPS involvement, firearm storage and access to firearms in the home Protective: none	Individual; family; peer	Youth who had committed suicide by firearm were less likely to have experienced a life crisis or have expressed suicidal thoughts compared to youth who had committed suicide by other means. Mental health and substance use were not associated with suicide by firearm 61% of youth who committed suicide by firearm accessed the gun in their home; 78% of these youth used a gun that was unlocked
Brent et al. (1993)	Case–control	67 youth aged $\leq$ 19 from 28 counties of western PA that committed suicide between July 1986 and August 1990 and 67 youth matched to suicide victims by age, gender, SES, and county of residence	Suicide by firearm	Risk: number and type of firearms available in the home, presence of loaded firearms in the home Protective: none	Family	Suicide victims who used firearms were more likely to have a gun in the home compared with suicide victims who died by other methods Suicide victims who had access to handguns were most likely to die by firearms, followed by those with access to long-guns only, while those without access to firearms were least likely to die by firearms The more firearms in the home, the more likely suicide by firearms was to occur
Carter et al. (2017a)	Cross-sectional	421 youth aged 14–24 seeking ED care at a hospital in Flint, MI	General firearm violence	Risk: retaliatory attitudes, past violence involvement, firearm carriage, ED visit for assault, substance use, mental health, failing grades, community violence exposure Protective: none	Individual; community	An ED visit for assault, marijuana use before conflict, and conflicts motivated by retaliation or personal belongings increased the odds that a conflict involved firearms Community violence exposure was not associated with firearm violence

Table 1 continued

Carter et al. (2015)	Prospective cohort	349 14–24 year olds who used drugs in the past 6 months and 250 drug-using non-assaulted youth seeking assault-injury care at an urban ED in Flint, MI	General firearm violence	Risk: ED assault-injury history, substance use disorders, firearm carriage, retaliatory attitudes, mental health disorders, criminal justice/gang involvement Protective: none	Individual; peer	Predictors of firearm violence included previous assault-injury, firearm possession, possessing firearms for protection, attitudes favoring retaliation, PTSD, and substance use disorder(s)
Carter et al. (2017b)	Retrospective cross-sectional	1758 children under 19 years old presenting to 16 pediatric EDs across the U.S. between 2004 and 2008	General firearm violence	Risk: insurance status, rural/urban, neighborhood disadvantage, vacant housing units, ED visit history Protective: none	Individual; community	Being uninsured or insured by public payer insurance, and higher levels of neighborhood disadvantage were risk factors for firearm injury. Higher rates of preceding ED visits were associated with firearm assault
Choi et al. (2017)	Retrospective cross-sectional	2005–2014 National violent death reporting data, firearm suicides among youth $\leq$ 21	Suicide by firearm	Risk: mental health, depressed mood, substance abuse, recent suicide attempt, disclosure of suicidal intent, history of crisis, recent death of family/friends, recent suicide of family/friend, access to firearms in the home, firearm storage Protective: none	Individual; family; peer	Youth who committed suicide by firearm were less likely to have had mental health or substance abuse problems, depressed mood, a recent suicide attempt, or to have disclosed their suicide intent before their death, and more likely to have experienced a life crisis compared to youth who died by other means Two-thirds of firearm suicide victims used guns that belonged to parents or other family members
Culyba et al. (2018)	Case–control	Urban adolescent males ages 10–24 who were victims of gunshot assault injury seeking care at trauma centers in Philadelphia, PA	Firearm victimization	Risk: none Protective: positive adolescent-adult connection, supportive familial connection, and supportive parental connection	Family; community	A positive connection to parents and other adults was not associated with firearm assault Among youth with greater involvement in violence, a supportive relationship with parents was associated with a higher risk of gunshot assault injury

Table 1 continued

Dahlberg et al. (2004)	Retrospective cross-sectional	Data from U.S. mortality survey, US adolescents aged 15 or older	Firearm victimization and suicide by firearm	Risk: presence of firearms in the home, number and type of firearms, storage practice Protective: none	Family	Individuals with a gun in their home were more likely to be injured or commit suicide by firearm than those without a firearm in their home, regardless of firearm type or storage practices
Dong et al. (2017)	Case-crossover	123 male gunshot assault victims between 10 and 24 years old seeking care from an urban ED located in Philadelphia, PA between 2005 and 2009	Firearm victimization	Risk: presence of friends, absence of guardians, hanging out in an outdoor public space, unstructured activities, weapon carrying, substance use, neighborhood disadvantage Protective: none	Individual; family; peer; community	Presence of friends, absence of guardians, unstructured activities, and neighborhood disadvantage were all associated with an increased risk of firearm assault The concurrence of multiple risk factors and neighborhood disadvantage was associated with a greater risk of being shot
Erickson et al. (2006)	Cross-sectional	510 girls between ages 14–17 in Toronto, Philadelphia, Amsterdam and Montreal	Firearm perpetration	Risk: substance use, alcohol use, illicit drug dealing, involvement in gang fights, delinquent behavior before age 13, past 12-month delinquent behavior, drug use within neighborhood Protective: none	Individual; Peer; Community	Past year delinquency was positively associated with threatening or attempting to hurt someone with a firearm Girls engaging in heavy alcohol consumption were 2.3 times as likely to threaten or attempt to hurt someone with a firearm
Goldstick et al. (2017)	Prospective cohort study	Substance-using youth ages 14–24 seeking ED care for assault-related injury compared with a sampled group of non-assault injured youth	General firearm violence	Risk: violent behavior, mental health, substance use, retaliatory attitudes, self-efficacy to avoid fighting, aggression, peer influences, parental behavior, community violence exposure Protective: none	Individual; peer; community	Exposure to firearm threats was the most robust risk factor associated with future firearm violence, followed by witnessing or hearing about community violence, negative peer influences (e.g. peer weapon carrying, substance use and legal problems), partner violence, and fighting

Table 1 continued

Hohl et al. (2017)	Case–control	161 13–20 year old homicide victims in Philadelphia, PA and 172 randomly selected 13–20 year old controls	Firearm victimization	Risk: personal substance use, caregiver substance use, neighborhood substance use availability Protective: none	Individual; family; community	A history of personal substance use and caregiver substance use were independent risk factors for firearm homicide victimization Areas with high density of alcohol outlets were associated with higher odds of firearm homicide victimization
Huebner et al. (2016)	Cross-sectional	1540 gun assault incidents that occurred in St. Louis, MO between 2002 and 2004	Firearm victimization	Risk: neighborhood rates of gang membership Protective: none	Community	Neighborhoods with high gang membership had twice the rate of gun assault as neighborhoods with low gang membership Proximity to high gang membership neighborhoods was associated with an elevated rate of gun assault
Kondo et al. (2017)	Case–control and case-crossover	135 males gun-shot victims aged 10–24 from Philadelphia, and 274 controls	Firearm victimization	Risk: none Protective: location under urban tree cover	Community	Urban tree cover was protective for victimization by gun assault, particularly in low income areas
Loeber et al. (1999)	Prospective cohort study	3 samples of Pittsburgh youth who were in grades 1,4, and 7 when the study began in 1987–1988	Firearm victimization	Risk: delinquency, low academic achievement, depressed mood, family functioning, household firearm ownership, firearm carriage, poor perception of neighborhood, low SES neighborhood Protective: none	Individual; family; community	Poor academic achievement, depressed mood, engaging and persisting in delinquency and personal firearm ownership were all associated with increased odds of firearm victimization Household firearm ownership, poor family functioning, and living in a low SES neighborhood all increased odds of firearm victimization relative to controls
Madan et al. (2001)	Cross-sectional	743 patients admitted to an ED in New Orleans, LA over a 6-month interval	Firearm victimization	Risk: substance use Protective: none	Individual	Being victimized by gunshot was directly associated with positive alcohol or drug screens
Mcgee et al. (2017)	Cross-sectional	500 low-SES, African American youth aged 12–18 in Virginia	Firearm perpetration	Risk: direct and indirect violence exposure; peer victimization Protective: none	Individual; peer	Exposure to violence through direct victimization was the most robust predictor of future gun related delinquency, followed by peer victimization and indirect victimization

Table 1 continued

Miller et al. (2007)	Cross-sectional	Survey-based estimates of household firearm ownership for 50 states obtained from the 2001 BRFSS	Firearm victimization	Risk: Household firearm prevalence (% individuals living in households with firearms) Protective: none	Family; community	Household firearm prevalence at the state-level was positively associated with firearm victimization Higher rates of robbery and aggravated assault in a community increased risk of youth firearm homicides
Murnan et al. (2004)	Cross-sectional	Data from 38 states that participated in the 2001 YRBS	Firearm victimization	Risk: weapon carriage, physical fighting, substance use, mental health issues, truancy, failing grades, gun laws, crime rates, firearm ownership within community Protective: none	Individual; community	Higher prevalence of firearm ownership at the state-level was independently and positively associated with child firearm mortality
Papachristos et al. (2012)	Cross-sectional	763 high-risk individuals between 15 and 53 years old in Boston's Verdean community	Firearm victimization	Risk: social network density, percent of peers who are gang members, percent of close peers who have been shot, average social distance to shooting victims Protective: none	Peer	Network proximity to a gunshot victim is associated with a greater likelihood of experiencing gunshot injury. This association is more pronounced for gang members
Papachristos et al. (2015)	Cross-sectional	10,531 police-involved youth in Newark, NJ	Firearm victimization	Risk: gang membership, proximity to gang members Protective: none	Peer	Direct or indirect association with a gang member is associated with an increased risk of gunshot victimization
Paris et al. (2002)	Case–control	45 non-fatal gun injury patients ages 11–18 seeking care at an urban ED, and 50 age and gender matched controls	Firearm victimization	Risk: drug use, prior arrest, depression, family structure, parental supervision, gun access, peer drug use, gang membership, problems at school, neighborhood safety Protective: none	Individual; family; peer; community	Living with less than two parents, skipping class, and prior arrest, emerged as independent risk factors associated with firearm injury
Ruback et al. (2011)	Prospective cohort	12,454 youth in grades 7–12 in 132 U.S. schools	Firearm victimization and firearm perpetration	Risk: household access to firearms Protective: none	Family	Easy access to firearms at home increased the likelihood of violent offending and violent victimization excluding homicide. 67% of adolescent cases who committed suicide used a gun they found at home
Shah et al. (2000)	Case–control	Colorado adolescents who committed suicide between 1991 and 1993	Suicide by firearm	Risk: mental health problems, conduct disorder, substance abuse, access to firearms in the home Protective: none	Individual; family	Household access to firearms, conduct disorder, and mental health problems were risk factors for suicide by firearms

Table 1 continued

Spano et al. (2008)	Prospective cohort	1295 youth aged 9–19 living in 12 high-poverty neighborhoods in Mobile, AL	Firearm victimization	Risk: gang membership, gun carrying, employment and deviant lifestyles Protective: none	Individual; peer	Gun carrying, gang membership and employment status are risk factors for firearm victimization. The effects of gang membership on firearm victimization are mediated by gun carrying, employment status, and deviant lifestyles
Stevens et al. (2001)	Cross-sectional	3145 10–12 year old children and 3145 parents	Firearm perpetration	Risk: substance use, risk taking, parental support and control, gun ownership and storage in the home Protective: none	Individual; family; peer	Peer gun use, drinking alcohol, and having access to firearms in the home were risk factors for early adoption of firearm shooting
Sumner et al. (2016)	Case–control	421 individuals arrested for firearm violent crimes between 2009 and 2014	Firearm perpetration	Risk: violent victimization, delinquency, school suspension, school dropout, child welfare involvement Protective: None	Individual; family	Previous community probation and gunshot wound predicted violent firearm offending Greater CPS involvement was associated with firearm violence perpetration
Wilkinson et al. (2009)	Mixed-methods cross-sectional	416 violent male offenders from disadvantaged NYC neighborhoods	General firearm violence	Risk: peer network composition, peer alcohol and drug use, peer gun carrying/use, and peer criminal behavior	Peer	Respondents reported that their peers were heavily involved in gun-related behaviors. Peers were often co-offenders in violent gun events. Retaliation was a top reason for firearm violence

School and community-level factors The influence of the school context on general firearm violence is largely unknown given that no studies examined school-level influences. The community context has been studied, though the findings are mixed. While community violence was not associated with general firearm violence in one study (Carter et al., 2017a), Goldstick et al. (2017) found that specific indicators of community violence exposure (i.e., "I have seen someone shot," "I have heard gun shots," "Seen gangs in neighborhood," and "My house was broken into") predicted future general firearm violence. Neighborhood disadvantage (i.e., % households $<$ 150% of the poverty level) and vacancy rate were also associated with youths' general firearm violence (Carter et al., 2017b). Geographic location (e.g., metropolitan, rural) was not associated with general firearm violence.

Firearm victimization

All 15 studies that focused on firearm violence victimization were quantitative, with six using a cross-sectional design, six employing a case–control design, and only three implementing a prospective cohort design. Thirteen of the studies focused on risk factors for firearm victimization, while only two studies (i.e., Culyba et al., 2018; Kondo et al., 2017) examined protective factors. Altogether, these 15 studies examined risk and protective factors across multiple social-ecological levels including at the individual- (n = 7), family- (n = 8), peer- (n = 5), school- (n = 1), and community-levels (n = 9). Notably, only one of the studies included unintentional firearm victimization in their outcome (i.e., Murnan et al., 2004); the other 14 studies focused solely on intentional firearm victimization.

Individual-level factors Delinquency (Paris et al., 2002), carrying firearms (Spano et al., 2008), using substances (Hohl et al., 2017; Madan et al., 2001), truancy (Paris et al., 2002), and low academic achievement (Loeber et al., 1999) were identified as risk factors of firearm related victimization among children and youth. Of these, substance use was consistent across two studies. Madan et al. (2001) found that youth admitted to a medical center for a firearm injury were more likely to test positive for alcohol and/or drugs in their system than youth admitted for other types of injuries. More recent findings by Hohl et al. (2017) corroborate these results. Dong et al. (2017), however, found that substance use did not independently affect the likelihood of being a victim of a gunshot assault. Yet, they found that adolescents who used drugs/alcohol in combination with other risky activities (e.g., weapon carrying, engaging in unstructured activities) were 9.90 times more likely to be shot (Dong et al., 2017).

Youth with a history of behavioral problems and delinquency were also more likely to be victimized by a firearm (Loeber et al., 1999; Paris et al., 2002). Those who miss school (Paris et al., 2002) and have low academic achievements (Loeber et al., 1999) were at greater risk of victimization. Paris et al. (2002) found in their case–control study that having a prior arrest record increased the odds of experiencing a non-fatal firearm injury. Spano et al. (2008) found that carrying a firearm increased the risk of firearm victimization by approximately 150%. Conversely, Murnan et al. (2004) found that after controlling for prevalence of firearm ownership within a state, the prevalence of students carrying a firearm or other weapon was not associated with the likelihood of adolescent firearm mortality. This discrepancy between Spano et al. (2008) findings and Murnan et al. (2004) findings may be attributed to differences in study design and analysis. Spano et al. (2008) used a prospective cohort design with data from individual youth, while Murnan et al. (2004) implemented a cross-sectional study using state-level data.

Family-level factors Among the most salient family-level risk factors for firearm violence victimization is access to firearms in the home (Culyba et al., 2018; Dahlberg et al., 2004; Miller et al., 2007; Loeber et al., 1999; Ruback et al., 2011). In fact, findings from three nationally-representative studies found that the presence of a firearm in the home increased the risk of firearm homicides among children and adolescents (Dahlberg et al., 2004; Miller et al., 2007; Ruback et al., 2011).

Family structure and family relations are also predictive of firearm injury. One study indicated that firearm injury risk increased in households with less than two parents compared to two-parent households (Paris et al., 2002). Additionally, youth who report not being close to their parents (i.e., mother and/or father) are more likely to experience a firearm injury or death (Loeber et al., 1999). Low parental supervision increases the odds of firearm victimization (Dong et al., 2017; Loeber et al., 1999). Contrary to the findings of Dong et al. (2017) and Loeber et al. (1999), Culyba et al. (2018) found that reporting a positive connection to parents did not lessen the likelihood of being shot, and youth reporting family support were *more* likely to experience a gunshot injury (Culyba et al., 2018). Their study, however, included youth after suffering a firearm injury. Thus, it is possible that youth reported high support of family members because their injury motivated a supportive reaction. Hohl et al. (2017) found that youth whose caregivers had a history of drug use were more likely to be victims in a firearm homicide than those that did not.

Peer-level factors Overall, findings from studies focused on peer-level influences demonstrate that peer relations influence youths' likelihood of experiencing a firearm injury, but the findings are inconsistent. Dong et al. (2017) found that youth were more likely to be injured with a firearm when they were with their peers compared to when they were with family members. Additionally, among a sample of high-risk individuals, Papachristos et al. (2012) found that the closer an individual is to a gunshot victim in their social network, the greater the risk that that person will experience a fatal or nonfatal firearm injury. Analyses examining the criminality of peers shed further light into this relationship. For example, Papachristos et al. (2015) found that associating with gang members and/or other co-offending networks increased the possibility of a firearm assault. Contrary to these findings, results from other studies suggest that involvement with antisocial peers may not be as influential as other risk factors (Paris et al., 2002; Spano et al., 2008). Paris et al. (2002) found that membership in a gang was not associated with firearm injury. While Spano et al. (2008) found a significant bivariate relationship between gang membership and firearm victimization, further analysis revealed that gang membership was not predictive of victimization after controlling for demographics, family factors, and deviant lifestyles. Inconsistencies in these results may be attributed to differences in samples. Papachristos et al. (2012, 2015), for example, studied individuals who had contact with the police resulting in an older sample than other studies (Spano et al., 2008; Paris et al., 2002).

School and community-level factors No studies have focused on school-level factors for victimization. The nine studies that focused on community-level suggest that firearm assaults and homicides are more likely to occur within communities with low SES, few resources, and high levels of disadvantage and disorder (Dong et al., 2017; Huebner et al., 2016; Loeber et al., 1999; Miller et al., 2007). In addition to neighborhood socioeconomic variables, researchers have demonstrated that the prevalence of firearms, illegal drug markets, alcohol outlets, and gang membership within communities increase the odds of victimization among children and adolescents (Hohl et al., 2017; Huebner et al., 2016; Miller et al., 2007; Murnan et al., 2004). In fact, Huebner et al. (2016) found that the prevalence of firearm assaults in areas with high gang membership were double those in areas with low membership. Additionally, their findings suggest a contagion effect with nearby geographic areas also experiencing higher rates of firearm assaults (Huebner et al., 2016). This finding is consistent with Miller et al.'s (2007) finding that higher rates of violent crime (i.e., robbery and aggravated

assault) within a community can increase the risk of youth firearm homicides. Contrary to these findings, however, Paris et al. (2002) found that neighborhood safety was not associated with firearm victimization. This inconsistency highlights that the use of objective versus subjective measures of neighborhood-level influences may produce different findings given that Huebner et al. (2016) and Miller et al. (2007) used objective measures, while Paris et al. (2002) measured neighborhood safety using youths' perceptions.

Community-level variables appear to compound the effects of individual- and peer-level risks. Dong et al. (2017), for example, examined the concurrence of individual risk (i.e., carrying weapon and substance use), being with peers, and neighborhood socioeconomic status and disorganization. They found that while these factors were independently important, when taken in conjunction, the odds of firearm victimization were further increased (Dong et al., 2017). Neighborhood effects also appear to supersede supportive family connections. Researchers have found that in low-income urban areas, connections to family did not protect against victimization (Culyba et al., 2018).

Only two studies in our review of firearm victimization literature explored protective factors. Kondo et al. (2017) examined the relationship between tree coverage and risk of firearm assault among youth living in urban areas. Results from this study show that urban green spaces may reduce the risk of firearm victimization, and this was found to be particularly true in low-income areas (Kondo et al., 2017). Culyba et al. (2018) found no association between positive adult connection and gunshot assault injury among adolescent males in low-resource, urban neighborhoods.

Firearm perpetration

Three of the five studies of firearm violence perpetration employed a cross-sectional study design (i.e., Erickson et al., 2006; McGee et al., 2017; Stevens et al., 2001). One used a matched case–control design (i.e., Sumner et al., 2016) and one used a prospective cohort design (i.e., Ruback et al., 2011). These studies examined risk factors at the individual (n = 4), family (n = 3), peer (n = 3), and community levels (n = 1). None of the studies assessed factors at the school level, included analysis of protective factors, or focused on unintentional firearm violence perpetration.

Individual-level factors Prior exposure to firearm violence, both directly and indirectly, is a salient risk factor for using and perpetrating firearm crimes. In a recent study of youth ages 12–18, McGee et al. (2017) found that being threatened or assaulted with a firearm, or witnessing a shooting at their school or in their community increased the odds of engaging in firearm crime. Of these, being personally threatened or assaulted with a firearm was the most robust risk factor (McGee et al., 2017). These findings are corroborated with results from a study by Sumner et al. (2016), who found that experiencing a prior firearm injury was associated with the highest risk of subsequent firearm violence perpetration.

In addition to violence exposure, engagement in alcohol and drug use and delinquency are risk factors for firearm violence perpetration and usage. Stevens et al. (2001) found that youth who consumed alcohol were more likely to use a firearm. This finding is consistent with Erickson et al. (2006) finding that using a firearm to threaten other individuals is more pronounced among girls who heavily consume alcohol. Furthermore, having a history of delinquency puts youth at higher risk for subsequent firearm violence perpetration (Erickson et al., 2006; Sumner et al., 2016).

Family-level factors Access to firearms within the household emerged as a family-level risk factor for perpetration in two studies (Ruback et al., 2011; Stevens et al., 2001). In addition to household firearm access, Sumner et al. (2016) found that youth from families in which child welfare services were involved had a higher likelihood of engaging in firearm violence perpetration compared to youth from families where child welfare services were not involved.

Peer-level factors Youth with peers who experienced firearm victimization are more likely to engage in firearm-involved crimes, even if they themselves were not victims (McGee et al., 2017). Furthermore, having friends, including fellow gang members, who use firearms also increased the odds of firearm usage (Stevens et al., 2001; Erikson et al., 2006).

School and community-level factors While limited to one study, Erickson et al. (2006) found that drug use or sale in an adolescent's neighborhood had no effect on their firearm violence perpetration. This study, however, was limited to female gang members.

Suicide by firearm

All five of the studies that focused on suicide by firearm applied quantitative analyses. Three of the studies used a retrospective, cross-sectional study design (i.e., Azrael

et al., 2004; Choi et al., 2017; Dahlberg et al., 2004), while the other two studies used a matched case–control design (i.e., Brent et al., 1993; Shah et al., 2000). Three studies assessed individual-level factors, all five explored family-level factors, and two focused on peer-level factors. None of the studies looked at school- or community-level influences, or examined protective factors.

Individual-level factors Researchers have focused on mental health history, previous suicide attempt, presence of a life crisis, and engagement in negative behaviors (e.g., substance use) as individual-level risk factors for committing suicide by firearm. Overall, results from these studies have been inconsistent. In fact, the findings differed from each of the three studies examining mental health as a risk factor (i.e., Choi et al., 2017; Azrael et al., 2004; Shah et al., 2000). Choi et al. (2017) found that youth who died by suicide using firearms were less likely to have a mental health issue and less likely to have disclosed their suicide intent compared to those who died by suicide using other means. Azrael et al. (2004) found that having a mental health issue or expressing suicidal thoughts in the past were not associated with a greater likelihood of committing suicide with a firearm compared to committing suicide by other means. Shah et al. (2000), however, found that youth under age 18 who committed suicide using a firearm were more likely to have been treated by a mental health professional compared to youth who committed suicide by other means.

Choi et al. (2017) and Shah et al. (2000) tested whether having a previous suicide attempt increased the risk of committing suicide with a firearm. Choi et al. (2017) found that adolescents who died by a firearm suicide were less likely to have recently attempted suicide compared to those who died by other means. Shah et al. (2000), on the other hand, found that a previous suicide attempt was not associated with committing suicide by firearm. Similarly, findings were mixed regarding whether experiencing a life crisis increased the risk of a firearm suicide. Azrael et al. (2004) did not find a relationship between experiencing a life crisis and risk of committing suicide by firearm while Choi et al. (2017) did find a relationship.

It remains unclear whether engaging in negative behaviors serves as a risk factor for committing suicide by firearm. Choi et al. (2017) found that youth who commit suicide using a firearm are less likely to have a substance use problem and equally as likely to have legal problems or problems at school compared to those who commit suicide by other means. Yet, Shah et al. (2000) found that alcohol abuse and being disruptive at school were associated with an increased risk of committing suicide by firearm compared to committing suicide by other means. Findings from the study by Azrael et al. (2004), on the other hand, suggest that no relationship exists between substance use and suicide by firearm.

These inconsistencies in the literature are likely attributed to differences in measurement. For instance, with regard to mental health issues, Shah et al. (2000) used a more inclusive measure of psychiatric illness (i.e., having ever been treated by a mental health professional), whereas Azrael et al. (2004) and Choi et al. (2017) used the DSM-IV categories to determine presence of a mental health problem. Furthermore, Choi et al. (2017) and Shah et al. (2000) used accounts from family members or friends to assess whether youth had experienced a life crisis, had a previous suicide attempt, or used substances. Azrael et al. (2004), on the other hand, used reports from fire departments and law enforcement, social service/child protective services (CPS) records, and hospital records.

Family-level factors Findings from the five studies that examined family-level factors overwhelmingly highlight that access to firearms within the household is a significant risk factor for committing suicide by firearm even after controlling for other risk factors (Brent et al., 1993; Dahlberg et al., 2004; Shah et al., 2000). Azrael et al. (2004) found that in 61% of firearm suicides, the firearm used was accessed within the home. Furthermore, Choi et al. (2017) found that two-thirds of firearm suicide victims used firearms that belonged to their parents or another family member. Researchers have also found that youth are more likely to commit suicide with a firearm, as opposed to other means, when firearms in the home are unlocked or in plain sight (Azrael et al., 2004; Choi et al., 2017; Shah et al., 2000). The number of firearms and access to handguns (compared to long guns) in the home can increase the likelihood of suicide by firearm (Brent et al., 1993; Shah et al., 2000; Azrael et al., 2004; Choi et al., 2017). Only one study assessed factors beyond household firearm access. Azrael et al. (2004) found that CPS involvement did not influence whether youth used firearms or other means to commit suicide.

Peer-level factors Based on findings from the two studies that examined peer-level influences on committing suicide by firearm, the role of peers is unclear. Choi et al. (2017) and Azrael et al. (2004) found that youth who committed suicide by firearm were equally as likely to have had a friend commit suicide recently compared to youth who committed suicide using other methods. It is possible, however, that the influence of peers may differ depending on gender. Choi et al. (2017) found that females who reported a relationship problem were at greater odds of

committing suicide with a firearm compared to committing suicide by other means, though this was not true for males.

Discussion

Our scoping review provides a thorough assessment and synthesis of findings across 28 studies focused on risk and protective factors associated with youth firearm violence. Through our review, we found that most research on youth firearm violence has focused mostly on individual-level factors for predicting youth firearm victimization, perpetration, and suicide. With regard to individual-level factors, we found that substance use and prior violence involvement were more consistently predictive of firearm victimization and perpetration compared to suicide by firearm. Additionally, mental health factors were not a consistent predictor of any of the firearm outcomes that we reviewed. At the family level, we found that access to firearms in the home was a consistent risk factor for all firearm violence outcomes. Previous research on youth violence in general (i.e., not specifically firearm violence) has demonstrated that experiencing positive family relations protects youth from involvement in violence (Lösel & Farrington, 2012; Resnick et al., 2004), yet we found from our review that a positive parent-adolescent relationship was inconsistently predictive of youth firearm violence. This discrepancy highlights the importance of examining risk and protective factors specifically for youth firearm violence, and suggests that research on youth violence in general may not always generalize to youth firearm violence. Finally, we found that many peer-level (e.g., association with delinquent peers) and community-level (e.g., neighborhood safety) factors were inconsistently predictive of the firearm outcomes that we reviewed.

Our review highlighted several gaps in the literature. First, few researchers have examined protective factors that may reduce the likelihood of engaging in youth firearm violence. In fact, only two studies included in our review examined protective factors. Furthermore, the two studies that examined protective factors focused only on their main effects, and did not test whether the protective factors buffered against risk (i.e., moderation effects). We found, for example, that involvement with negative peers was identified as a salient risk factor for general firearm violence and firearm violence perpetration (Erikson et al., 2006; Goldstick et al., 2017; Wilkinson et al., 2009), but we do not have any insight into whether there are positive factors in youths' lives that can buffer the negative influence of negative peers. Unfortunately, with limited focus on buffering effects, we are unable to fully understand the complex interplay between risk and protective factors, which hinders our ability to develop tailored interventions, particularly for youth at highest risk for firearm violence.

Second, we found that the existing research on risk and protective factors for youth firearm violence is disproportionately focused on individual-level factors compared to other social-ecological levels. Less attention has been given to contextual factors, particularly school-level factors. None of the studies included in our review focused on school-level factors, and the studies that focused on family, peer, and community influences are somewhat narrow in scope. Studies that included family-level factors most often focused on family structure (e.g. single parent homes) and household access to firearms, and this was particularly true for youth firearm suicide and firearm perpetration. Most studies that included community-level factors addressed more macro-level issues such as neighborhood socioeconomic variables and focused less on social relationships (e.g., social capital, neighborhood guardianship). In addition to a limited understanding of factors within each ecological level, less than a third of the studies examined risk and protective factors across multiple ecological levels. Given that developmental science has emphasized that adolescent outcomes are influenced by the interaction of factors across levels (Bronfenbrenner, 1979), this is a significant omission in the literature that requires attention. Overall, these limitations emphasize the need to expand our understanding of risk and protection across multiple ecological levels, with a focus on understudied family, peer, and community-level factors. More attention to family process variables (e.g., warmth, support), parental attitudes, and family prevention behaviors (e.g., teaching firearm safety, setting rules about firearms) is currently needed. We also need to give greater attention to school-level factors, such as school social climate, relationships with teachers, school enrichment or extracurricular activities, school safety, and physical aspects of the school environment. Research that expands attention to community-level factors such as the influence of community organizations and youth programs, pro-social bonds to positive neighborhood institutions, and the built environment is also needed to fill glaring gaps in the literature.

Another significant gap we identified through our review is the lack of attention to mediating effects, or the mechanism by which risk and protective factors may operate to increase (or decrease) firearm outcomes. Most studies focused solely on the direct effects of risk factors on youth firearm violence which means we do not know much about the psychological, social, and contextual mechanisms undergirding firearm violence. It is also quite likely that such mechanisms may differ for intentional or unintentional firearm violence and victimization. Future research that conceptualizes and empirically tests mechanisms of

risk will help inform tailored prevention strategies that address risk for firearm violence across multiple levels.

Another evident gap in the literature is that we have almost no information regarding risk and protective factors for unintentional firearm violence. In fact, only one study included unintentional firearm violence in their measure of firearm victimization (i.e., Murnan et al., 2004). Yet, even with this study, we were unable to identify unique risk and protective factors for unintentional firearm injuries because the researchers examined unintentional and intentional firearm-related mortality as a single outcome. Thus, we need to build a research base for understanding the risk and protective factors associated specifically with unintentional firearm injuries. This gap in the literature is also indicative of the fact that no studies of children under 10 have been conducted regarding firearm violence, as this is the population most likely to experience unintentional injuries.

Finally, research on the risk and protective factors for youth firearm violence is methodologically limited in several ways. The majority of studies (54%; n = 15) used cross-sectional designs, which limits our understanding of temporal dimensions. We have a need for more prospective cohort studies to better understand antecedent risk and protection for youth firearm outcomes and to study mechanisms of risk and protection versus simply main effects. Most studies also used samples recruited from singular contexts such as emergency departments or high-risk urban areas. This limits significantly the generalizability of the findings. The field needs more research using probability samples and nationally representative samples. We also need more sophisticated and theoretically-driven analysis of the data we do have. Studies that utilize multi-level modeling are especially needed to better understand the interactions of social-ecological influences on youth firearm violence.

Limitations

Despite our efforts to provide a comprehensive scoping review of the literature, our findings are limited in a few ways. First, by focusing exclusively on published literature and excluding non-English literature, we may have missed relevant studies in our review. Additionally, our search strategy may not have identified all eligible studies. Yet, we employed rigorous methodology appropriate for scoping reviews (Arksey & O'Malley, 2005), which included a search across four databases, inclusion of studies identified by experts in the field, and a backward reference search of the citations listed in sentinel review papers. Nevertheless, by missing relevant studies, we may have introduced bias into our findings.

It is also important to acknowledge that while the focus population for our review was youth ages 0–17, we included studies that had a subset of their research population within our age criteria. This resulted in the inclusion of several studies that included individuals older than our focus age group. Unfortunately, for most of these studies, the percentage of youth between the ages of 0–17 in each sample was unclear. Findings from studies that included very few youth ages 0–17 may not be generalizable to youth in our focus age range. With that being said, the fact that our search resulted in so few studies of youth solely between the ages of 0–17 highlights the importance of future research examining risk and protective factors for firearm violence among this population.

Conclusions

While scholars have started to identify factors associated with firearm violence, findings from our scoping review highlight the need for additional conceptually-driven research on risk and protective factors for youth firearm violence, especially unintentional firearm violence, across multiple socio-ecological levels using longitudinal data and robust statistical methods. Future research is also needed to understand the underlying mechanisms by which risk and protective factors influence youth firearm violence. By identifying important gaps in the literature and directions for future research, this review sets an agenda for research designed to understand child and adolescent firearm victimization, perpetration, and suicide, and accelerate the implementation of prevention efforts.

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Compliance with ethical standards

Conflict of interest Drs. Schmidt, Pizarro, Lee, Branas, Zimmerman, and Ms. Rupp declare that they have no conflicts of interest.

Human and animal rights and Informed consent This article does not contain any studies with human participants or animals performed by any of the authors.

Appendix: Full PubMed search strategy

"Wounds, Gunshot/epidemiology"[Mesh:NoExp] OR ("wounds, gunshot"[majr] OR firearms[majr])AND "Risk"[Mesh] OR "Risk Assessment"[Mesh] OR "Risk Factors"[Mesh] OR "Protective Factors"[Mesh] OR "Risk Reduction Behavior"[Mesh] OR "Forecasting"[Mesh] OR "Risk-Taking"[Mesh] OR "Dangerous Behavior"[Mesh] OR "Risk Reduction Behavior"[majr] AND adolescent[MeSH] OR youth[MeSH] OR child[MeSH] OR teenager[tiab] OR teen[tiab] OR adolescent[tiab] OR adolescence[tiab]OR child[tiab] OR children[tiab] OR minor[tiab] OR delinquent[tiab] OR pediatric[tiab] OR youth[tiab] OR juvenile[tiab].

References

Arksey, H., & O'Malley, L. (2005). Scoping studies: Towards a methodological framework. *International Journal of Social Research Methodology, 8,* 19–32.

Azrael, D., Hemenway, D., Miller, M., Barber, C. W., & Schackner, R. (2004). Youth suicide: Insights from 5 years of Arizona child fatality review team data. *Suicide and Life-Threatening Behavior, 34,* 36–43.

Brent, D. A., Perper, J. A., Moritz, G., Baugher, M., Schweers, J., & Roth, C. (1993). Firearms and adolescent suicide. A community case–control study. *American Journal of Diseases of Children, 147,* 1066–1071.

Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by design and nature*. Cambridge, MA: Harvard University Press.

Carter, P. M., Cook, L. J., Macy, M. L., Zonfrillo, M. R., Stanley, R. M., Chamberlain, J. M., et al. (2017a). Individual and neighborhood characteristics of children seeking emergency department care for firearm injuries within the PECARN network. *Academic Emergency Medicine: Official Journal of the Society for Academic Emergency Medicine, 24*(7), 803–813. https://doi.org/10.1111/acem.13200

Carter, P. M., & Cunningham, R. M. (2016). Adequate funding for injury prevention research is the next critical step to reduce morbidity and mortality from firearm injuries. *Academic Emergency Medicine, 23,* 952–955. https://doi.org/10.1111/acem.12982

Carter, P. M., Walton, M. A., Goldstick, J., Epstein-Ngo, Q. M., Zimmerman, M. A., Mercado, M. C., et al. (2017b). Violent firearm-related conflicts among high-risk youth: An event-level and daily calendar analysis. *Preventive Medicine, 102,* 112–119. https://doi.org/10.1016/j.ypmed.2017.07.011

Carter, P. M., Walton, M. A., Roehler, D. R., Goldstick, J., Zimmerman, M. A., Blow, F. C., et al. (2015). Firearm violence among high-risk emergency department youth after an assault injury. *Pediatrics, 135,* 805–815. https://doi.org/10.1542/peds.2014-3572

Centers for Disease Control and Prevention. (2015). National Center for Injury Prevention and Control. *Web-based Injury Statistics Query and Reporting System* (*WISQARS*). http://www.cdc.gov/injury/wisqars. Accessed November 12, 2018.

Choi, N. G., DiNitto, D. M., & Marti, C. N. (2017). Youth firearm suicide: Precipitating/risk factors and gun access. *Children and Youth Services Review, 83,* 9–16. https://doi.org/10.1016/j.childyouth.2017.10.022

Cohn, D., Taylor, P., Lopez, M. H., Gallagher, C. A., Parker, K., & Maass, K. T. (2013). *Gun homicide rate down 49% since 1993 peak: Public unaware*. Washington, DC: Pew Research Center. Retrieved from June 8, 2019. https://www.pewsocialtrends.org/2013/05/07/gun-homicide-rate-down-49-since-1993-peak-public-unaware/

Culyba, A. J., Miller, E., Ginsburg, K. R., Branas, C. C., Guo, W., Fein, J. A., et al. (2018). Adult connection in assault injury prevention among male youth in low-resource urban environments. *Journal of Urban Health, 95,* 361–371.

Cunningham, R. M., Walton, M. A., & Carter, P. M. (2018). The major causes of death in children and adolescents in the United States. *New England Journal of Medicine*, *379*(25), 2468–2475.

Dahlberg, L. L., Ikeda, R. M., & Kresnow, M. J. (2004). Guns in the home and risk of a violent death in the home: Findings from a national study. *American Journal of Epidemiology, 160,* 929–936. https://doi.org/10.1093/aje/kwh309

Dong, B., Branas, C. C., Richmond, T. S., Morrison, C. N., & Wiebe, D. J. (2017). Youth's daily activities and situational triggers of gunshot assault in urban environments. *Journal of Adolescent Health, 61,* 779–785. https://doi.org/10.1016/j.jadohealth.2017.06.018

Erickson, P. G., Butters, J. E., Cousineau, M. M., Harrison, L., & Korf, D. (2006). Girls and weapons: An international study of the perpetration of violence. *Journal of Urban Health, 83,* 788–801. https://doi.org/10.1007/s11524-006-9038-5

Goldstick, J. E., Carter, P. M., Walton, M. A., Dahlberg, L. L., Sumner, S. A., Zimmerman, M. A., et al. (2017). Development of the SaFETy Score: A clinical screening tool for predicting future firearm violence risk. *Annals of Internal Medicine, 166,* 707–714. https://doi.org/10.7326/M16-1927

Hawkins, J. D., Catalano, R. F., & Arthur, M. W. (2002). Promoting science-based prevention in communities. *Addictive Behaviors, 27,* 951–976. https://doi.org/10.1016/S0306-4603(02)00298-8

Herrenkohl, T. I., Maguin, E., Hill, K. G., Hawkins, J. D., Abbott, R. D., & Catalano, R. F. (2000). Developmental risk factors for youth violence. *Journal of Adolescent Health, 26,* 176–186. https://doi.org/10.1016/S1054-139X(99)00065-8

Hohl, B. C., Wiley, S., Wiebe, D. J., Culyba, A. J., Drake, R., & Branas, C. C. (2017). Association of drug and alcohol use with adolescent firearm homicide at individual, family, and neighborhood levels. *JAMA Internal Medicine, 177,* 317–324. https://doi.org/10.1001/jamainternmed.2016.8180

Huebner, B. M., Martin, K., Jr., Moule, R. K., Pyrooz, D., & Decker, S. H. (2016). Dangerous places: Gang members and neighborhood levels of gun assault. *Justice Quarterly, 33,* 836–862. https://doi.org/10.1080/07418825.2014.984751

Kim, B. K. E., Gloppen, K. M., Rhew, I. C., Oesterle, S., & Hawkins, J. D. (2015). Effects of the communities that care prevention system on youth reports of protective factors. *Prevention Science, 16,* 652–662. https://doi.org/10.1007/s11121-014-0524-9

Kondo, M. C., South, E. C., Branas, C. C., Richmond, T. S., & Wiebe, D. J. (2017). The association between urban tree cover and gun assault: A case–control and case-crossover study. *American Journal of Epidemiology, 186,* 289–296. https://doi.org/10.1093/aje/kwx096

Loeber, R., DeLamatre, M., Tita, G., Cohen, J., Stouthamer-Loeber, M., & Farrington, D. P. (1999). Gun injury and mortality: The delinquent backgrounds of juvenile victims. *Violence and Victims, 14,* 339–352.

Lösel, F., & Farrington, D. P. (2012). Direct protective and buffering protective factors in the development of youth violence. *American Journal of Preventive Medicine, 43,* S8–S23.

Madan, A., Beech, D. J., & Flint, L. (2001). Drugs, guns, and kids: The association between substance use and injury caused by interpersonal violence. *Journal of Pediatric Surgery, 36,* 440–442.

McGee, Z. T., Logan, K., Samuel, J., & Nunn, T. (2017). A multivariate analysis of gun violence among urban youth: The impact of direct victimization, indirect victimization, and victimization among peers. *Cogent Social Sciences*. https://doi.org/10.1080/23311886.2017.1328772

Miller, M., Hemenway, D., & Azrael, D. (2007). State-level homicide victimization rates in the U.S. in relation to survey measures of household firearm ownership, 2001–2003. *Social Science and Medicine, 64,* 656–664.

Murnan, J., Dake, J. A., & Price, J. H. (2004). Association of selected risk factors with variation in child and adolescent firearm mortality by state. *Journal of School Health, 74,* 335–340.

Ouzzani, M., Hammady, H., Zbys, F., & Elmagarmid, A. (2016). Rayyan-a web and mobile app for systematic reviews (Version 5:210). Retrieved from https://doi.org/10.1186/s13643-016-0384-4

Papachristos, A., Braga, A., Piza, E., & Grossman, L. (2015). The company you keep? The spillover effects of gang membership on individual gunshot victimization in a co-offending network. *Criminology, 53,* 624–649.

Papachristos, A. V., Braga, A. A., & Hureau, D. M. (2012). Social networks and the risk of gunshot injury. *Journal of Urban Health, 89,* 992–1003.

Paris, C. A., Edgerton, E. A., Sifuentes, M., Seidel, J. S., Lewis, R. J., & Gausche, M. (2002). Risk factors associated with non-fatal adolescent firearm injuries. *Injury Prevention, 8,* 147–150.

Pollard, J. A., Hawkins, J. D., & Arthur, M. W. (1999). Risk and protection: Are both necessary to understand diverse behavioral outcomes in adolescence? *Social Work Research, 23,* 145–158. https://doi.org/10.1093/swr/23.3.145

Resnick, M. D., Ireland, M., & Borowsky, I. (2004). Youth violence perpetration: What protects? What predicts? Findings from the National Longitudinal Study of Adolescent Health. *Journal of Adolescent Health, 35,* 424-e1.

Ruback, R. B., Shaffer, J. N., & Clark, V. A. (2011). Easy access to firearms: Juveniles' risks for violent offending and violent victimization. *Journal of Interpersonal Violence, 26,* 2111–2138.

Shah, S., Hoffman, R. E., Wake, L., & Marine, W. M. (2000). Adolescent suicide and household access to firearms in Colorado: Results of a case–control study. *Journal of Adolescent Health, 26,* 157–163.

Spano, R., Freilich, J. D., & Bolland, J. (2008). Gang membership, gun carrying, and employment: Applying routine activities theory to explain violent victimization among inner city, minority youth living in extreme poverty. *Justice Quarterly, 25,* 381–410.

Stevens, M. M., Gaffney, C. A., Tosteson, T. D., Mott, L. A., Olson, A., Ahrens, M. B., et al. (2001). Children and guns in a well child cohort. *Preventive Medicine, 32,* 201–206. https://doi.org/10.1006/pmed.2000.0811

Sumner, S. A., Maenner, M. J., Socias, C. M., Mercy, J. A., Silverman, P., Medinilla, S. P., et al. (2016). Sentinel events preceding youth firearm violence: An investigation of administrative data in Delaware. *American Journal of Preventive Medicine, 51,* 647–655. https://doi.org/10.1016/j.amepre.2016.08.002

Wilkinson, D. L., McBryde, M. S., Williams, B., Bloom, S., & Bell, K. (2009). Peers and gun use among urban adolescent males: An examination of social embeddedness. *Journal of Contemporary Criminal Justice, 25,* 20–44.

Zaza, S., Wright-De Agüero, L. K., Briss, P. A., Truman, B. I., Hopkins, D. P., Hennessy, M. H., et al. (2000). Data collection instrument and procedure for systematic reviews in the guide to community preventive services. *American Journal of Preventive Medicine, 18,* 44–74.