



HHS Public Access

Author manuscript

JAMA Pediatr. Author manuscript; available in PMC 2020 December 10.

Published in final edited form as:

JAMA Pediatr. 2019 August 01; 173(8): 780–789. doi:10.1001/jamapediatrics.2019.1494.

Prevention of Firearm Injuries Among Children and Adolescents: Consensus-Driven Research Agenda from the Firearm Safety Among Children and Teens (FACTS) Consortium

Rebecca M. Cunningham, MD,

Department of Emergency Medicine, Michigan Medicine, University of Michigan, Ann Arbor

Patrick M. Carter, MD,

Department of Emergency Medicine, Michigan Medicine, University of Michigan, Ann Arbor

Megan L. Ranney, MD, MPH,

Department of Emergency Medicine, Alpert Medical School, Brown University, Providence, Rhode Island

Maureen Walton, MPH, PhD,

Department of Psychiatry, Michigan Medicine, University of Michigan, Ann Arbor

Corresponding Author: Rebecca M. Cunningham, MD, Department of Emergency Medicine, Michigan Medicine, University of Michigan, North Campus Research Complex, 2800 Plymouth Rd, Bldg10-G080, Ann Arbor, MI 48109 (stroh@umich.edu).

Author Contributions: Drs Cunningham and Carter had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Concept and design: Cunningham, Carter, Zimmerman, Ranney, Walton, Zeoli, Alpern, Branäs, Ehrlich, Goyal, Goldstick, Hargarten, King, Massey, Pizarro, Rowhani-Rahbar, Rivara, Rupp, Savolainen, Sigel.

Acquisition, analysis, or interpretation of data: Cunningham, Carter, Zimmerman, Ranney, Walton, Beidas, Goldstick, Hemenway, King, Massey, Ngo, Pizarro, Prosser, Rowhani-Rahbar, Rivara, Rupp.

Drafting of the manuscript: Cunningham, Carter, Zimmerman, Ranney, Ehrlich, Massey, Ngo, Sigel.

Critical revision of the manuscript for important intellectual content: Cunningham, Carter, Zimmerman, Ranney, Walton, Zeoli, Alpern, Branäs, Beidas, Ehrlich, Goyal, Goldstick, Hemenway, Hargarten, King, Massey, Ngo, Pizarro, Prosser, Rowhani-Rahbar, Rivara, Rupp, Savolainen.

Statistical analysis: Cunningham, Goldstick.

Obtained funding: Cunningham, Carter, Zimmerman, Ranney, Walton, Alpern, Branäs, Ehrlich, Hemenway, Hargarten, Rivara, Savolainen.

Administrative, technical, or material support: Cunningham, Zimmerman, Ranney, Branäs, Goyal, Hargarten, Massey, Ngo, Prosser, Rowhani-Rahbar, Rupp, Savolainen, Sigel.

Supervision: Cunningham, Zimmerman, Ranney, Branäs, Ehrlich, Massey.

Additional Contributions: Interviews to inform agenda development and rigorous review and rating of agenda items were conducted by the following practitioner stakeholders: Adelyn Allchin, MPH, Brigadier General (Retired) James Anderson, PhD, James Berlin, Vicka Chaplin, MA, MPH, Rochelle A. Dicker, MD, Greg Dorfman, JD, Joseph V. Erardi Jr, PhD, Chris Harris, Geraldine Hills, MNps, Ben Hoffman, MD, Joneigh Khaldun, MD, Tom O'Connor, BA, and LokMan Sung, MD. Rigorous review and ranking of agenda items was performed by the following external expert panelists: Emmy Betz, MD, MPH, University of Colorado School of Medicine; Joel Fein, MD, MPH, The Perelman School of Medicine, University of Pennsylvania; Shannon Frattaroli, PhD, Johns Hopkins Bloomberg School of Public Health; Jesus Ramirez-Valles, PhD, MPH, San Francisco State University; Daniel Webster, ScD, Johns Hopkins Bloomberg School of Public Health; and Doug Wiebe, PhD, The Perelman School of Medicine, University of Pennsylvania. Assistance conducting scoping reviews and writing review articles across 6 work groups that provided a critical foundation for this agenda for research was conducted by the following Firearm Safety Among Children and Teens (FACTS) Consortium Trainees: Kira Bromwich, BA, Brown University; Jonathan Jay, JD, DrPh, Harvard University; Rebecca Karb, MD, PhD, Brown University; Amanda Mauri, MPH, University of Michigan; Allante Moon, MPH, University of Michigan; Charles Mouch, MD, University of Michigan; Stephen Oliphant, MPP, University of Michigan; Carissa Schmidt, PhD, MPH, University of Michigan; and Mikaela Wallin, MA, Michigan State University; and the following FACTS research assistants: Zahra Asghar, BS, Brown University; Mikala Cox, MSW, University of Michigan; Melissa Goodman, University of Michigan; Jhuree Hong, University of Michigan; Stephanie Kostolansky, University of Michigan; Jaemin Park, University of Michigan; and Max Ozer-Staton, University of Michigan. They received no additional compensation for their work.

Conflict of Interest Disclosures: All authors reported receiving grants from the National Institutes of Health (NIH)/National Institute of Child Health and Human Development (NICHD) during the conduct of this study. No other disclosures were reported.

Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the funding agencies.

April M. Zeoli, PhD,

School of Criminal Justice, Michigan State University, East Lansing

Elizabeth R. Alpern, MD, MSCE,

Division of Emergency Medicine, Department of Pediatrics, Ann & Robert H. Lurie Children's Hospital, Northwestern University Feinberg School of Medicine, Chicago, Illinois

Charles Branas, PhD,

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

Rinad S. Beidas, PhD,

Department of Psychiatry, Perelman School of Medicine, University of Pennsylvania, Philadelphia

Department of Medical Ethics and Health Policy, Perelman School of Medicine, University of Pennsylvania, Philadelphia

Leonard Davis Institute of Health Economics, University of Pennsylvania, Philadelphia

Peter F. Ehrlich, MD, MSc,

Department of Surgery, Michigan Medicine, University of Michigan, Ann Arbor

Monika K. Goyal, MD, MSCE,

Children's National Medical Center, The George Washington University, Washington, DC

Jason E. Goldstick, PhD,

Department of Emergency Medicine, Michigan Medicine, University of Michigan, Ann Arbor

David Hemenway, PhD,

Department of Health Policy and Management, T.H. Chan School of Public Health, Harvard University, Cambridge, Massachusetts

Stephen W. Hargarten, MD, MPH,

Department of Emergency Medicine, Comprehensive Injury Center, Medical College of Wisconsin, Milwaukee

Cheryl A. King, PhD,

Department of Psychiatry, Michigan Medicine, University of Michigan, Ann Arbor

Lynn Massey, MSW,

Department of Emergency Medicine, Michigan Medicine, University of Michigan, Ann Arbor

Quyen Ngo, PhD, LP,

Department of Emergency Medicine, Michigan Medicine, University of Michigan, Ann Arbor

Jesenia Pizarro, PhD,

School of Criminology and Criminal Justice, Arizona State University, Phoenix

Lisa Prosser, PhD,

Child Health Evaluation and Research Center, Department of Pediatrics, Michigan Medicine, University of Michigan, Ann Arbor

Department of Health Management and Policy, School of Public Health, University of Michigan, Ann Arbor

Ali Rowhani-Rahbar, MD, MPH, PhD,

Department of Epidemiology, School of Public Health, University of Washington, Seattle

Departments of Pediatrics, School of Medicine, University of Washington, Seattle

Harborview Injury Prevention and Research Center, University of Washington, Seattle

Fredrick Rivara, PhD,

Departments of Pediatrics, School of Medicine, University of Washington, Seattle

Harborview Injury Prevention and Research Center, University of Washington, Seattle

Laney A. Rupp, MPH,

Department of Health Behavior and Health Education, School of Public Health, University of Michigan, Ann Arbor

Eric Sigel, MD,

Section of Adolescent Medicine, Department of Pediatrics, University of Colorado School of Medicine, Aurora

Jukka Savolainen, PhD,

Institute for Social Research, University of Michigan, Ann Arbor

Marc A. Zimmerman, PhD

Department of Health Behavior and Health Education, School of Public Health, University of Michigan, Ann Arbor

Abstract

IMPORTANCE—Firearm injuries are the second leading cause of death among US children and adolescents. Because of the lack of resources allocated to firearm injury prevention during the past 25 years, research has lagged behind other areas of injury prevention. Identifying timely and important research questions regarding firearm injury prevention is a critical step for reducing pediatric mortality.

OBJECTIVE—The Firearm Safety Among Children and Teens (FACTS) Consortium, a National Institute for Child Health and Human Development-funded group of scientists and stakeholders, was formed in 2017 to develop research resources for the field, including a pediatric-specific research agenda for firearm injury prevention to assist future researchers and funders, as well as to inform cross-disciplinary evidence-based research on this critical injury prevention topic.

EVIDENCE REVIEW—A nominal group technique process was used, including 4 key steps (idea generation, round-robin, clarification, and voting and consensus). During idea generation, stakeholders and workgroups generated initial research agenda topics after conducting scoping reviews of the literature to identify existing gaps in knowledge. Agenda topics were refined through 6 rounds of discussion and survey feedback (ie, round-robin, and clarification steps). Final voting (using a 5-point Likert scale) was conducted to achieve consensus (70% of consortium ranking items at 4 or 5 priority for inclusion) around key research priorities for the next 5 years of research in this field. Final agenda questions were reviewed by both the stakeholder group and an external panel of research experts not affiliated with the FACTS Consortium. Feedback was integrated and the final set of agenda items was ratified by the entire FACTS Consortium.

FINDINGS—Overall, 26 priority agenda items with examples of specific research questions were identified across 5 major thematic areas, including epidemiology and risk and protective factors, primary prevention, secondary prevention and sequelae, cross-cutting prevention factors, policy, and data enhancement.

CONCLUSIONS AND RELEVANCE—These priority agenda items, when taken together, define a comprehensive pediatric-specific firearm injury prevention research agenda that will guide research resource allocation within this field during the next 5 years.

Firearms are the second leading cause of death¹ among children and adolescents aged 1 to 18 years in the United States and responsible for more than 2570 deaths and nearly 12 000 nonfatal injuries requiring emergency department treatment in 2017.^{1,2} Pediatric firearm injuries result from a range of causes, including the unintentional discharge of a firearm, self-inflicted wounds, or the escalation of interpersonal violence. Nearly 265 million firearms are in civilian hands in the United States,³ and a 44% increase in pediatric firearm mortality rates has been documented during the past 5 years.²

Despite recent strides by private foundations and states, research funding, publications, and evidence-based programs to decrease pediatric firearm injuries have lagged substantially behind those for other forms of injury.^{4,5} Successes in reducing significant child and adolescent health threats from communicable diseases and motor vehicles required extensive scientific resources and translation of epidemiologic evidence to inform practical solutions and change policy. When considering road traffic safety, the great success of these evidence-based strategies has reduced pediatric motor vehicle crash injury and death without interfering with the ability of US citizens to own and responsibly operate cars. A 2013 Institute of Medicine report⁶ described the need for innovative research that addresses firearm injuries. This seminal report that was focused on firearm injuries brought substantial attention to this issue but included all age groups without specific discussion of issues affecting pediatric populations. Currently, there is a substantial deficit of data for pediatric firearm injuries. Such data are essential for developing and implementing efficacious firearm injury prevention strategies and policies. The development of a pediatric-specific research agenda is a needed next step to focus efforts to decrease the second leading cause of pediatric mortality.

Building on this critical need, the National Institute for Child Health and Human Development funded the Firearm Safety Among Children and Teens (FACTS) Consortium in 2017. The primary goal of FACTS, which includes 25 scientists from 12 academic institutions and 12 stakeholders (eAppendix in the Supplement), is to reduce pediatric firearm injury and death while also respecting firearm ownership as a part of US society. FACTS includes multidisciplinary expertise from medicine (emergency medicine, pediatrics, pediatric trauma surgery, and psychiatry), public health (health behavior and education, health policy, and epidemiology), criminology, psychology, sociology, and the fields of data and implementation science. Stakeholder members included a diverse group of interested parties, including firearm owners, firearm safety trainers, educators, faith-based leaders, law enforcement professionals, and hunting enthusiasts, who share a common goal of decreasing fire-arm injury and deaths among children. The consortium is developing research resources

to inform the prevention of pediatric fire-arm injury and death, including the following: (1) training a cadre of postdoctoral trainees and graduate and undergraduate students to increase the pipeline of firearm researchers; (2) creating conferences, webinar series, and other resources to educate researchers and policy makers about firearm injury science; (3) creating an accessible data archive on pediatric firearm injury (<https://www.childfirearmsafety.org>); and (4) funding projects to generate preliminary data that inform future research to decrease the toll of child and adolescent injury and death from firearms.

The first focus of the consortium was to conduct substantive scoping reviews of the existing literature⁷⁻¹¹ to inform the current state of the science and to identify and prioritize gaps in research. This article presents a rigorously generated comprehensive research agenda specific to pediatric firearm injury that is intended to aid in guiding the next 5 years of research for the field. This research agenda describes priorities for preventing both unintentional (accidental) and intentional (ie, homicide and suicide) firearm injury and death, as well as for preventing long-term consequences of pediatric firearm injury and mortality.

Methods

Overview of the Agenda Development Process

A modified nominal group technique (NGT)¹²⁻¹⁷ was used to develop the research agenda (eFigure in the Supplement). Nominal group technique is a widely accepted, highly structured process for collecting data and developing consensus among a panel of content experts.¹²⁻¹⁸ The technique involves the following 4 phases: silent idea generation, round-robin presentation of ideas and further idea generation, clarification (or narrowing and grouping) of ideas, and voting or ranking of preferred ideas to generate a prioritized agenda.¹²⁻¹⁸ Nominal group technique was selected rather than other approaches (eg, Delphi technique) as it generates a larger number of ideas than do traditional consensus approaches and the structured process serves to mitigate potential sources of bias.^{16,18,19} Agenda development occurred between January and October 2018, and included 45 workgroup meetings, 2 consortium-wide video conference meetings, and 4 surveys administered via Qualtrics. The NGT process was facilitated by the FACTS leadership team (R.M.C., P.M.C., and M.A.Z.), all of whom have prior NGT experience. Written minutes and/or audio recordings of all consortium meetings were maintained by nonvoting research staff.

FACTS Consortium Expert Panel and Workgroup Formation

Expert panelists (eAppendix in the Supplement) have all published pediatric firearm research and are recognized leaders within their field of expertise. Panelists were organized into the following 6 thematic workgroups: surveillance and epidemiology, risk and protective factors, primary prevention, secondary prevention, policy, and data and methods.

Silent Idea Generation: Literature Review and Initial Research Priorities

Each workgroup conducted a scoping literature review with the objective of identifying current research knowledge and gaps in a specific topic area.⁷⁻¹¹ The reviews were conducted across the range of firearm outcomes that were defined at the outset for clarity

(Box). Concurrently, research staff and expert panelists conducted semistructured interviews with 12 stakeholders (eAppendix in the Supplement) to identify independently formulated priorities for future research. Stakeholder interviews were recorded and transcribed by research staff with summaries shared with each workgroup. Stakeholder input was sought at this stage to ensure inclusion of their priorities at the outset and avoid biasing the agenda. After performing the literature reviews and receiving stakeholder input, each workgroup generated a preliminary internal list of up to 10 research agenda priorities (51 items), with a focus on those that would be most important for the next 5 years of research.

Round-Robin Phase: Presentation of Research Priorities and Further Idea Generation

Next, we conducted a 2-phase round-robin process to obtain feedback from the expert panel on the 51-item preliminary research agenda. In the first phase, the expert panel completed a structured survey to allow for the generation of novel research agenda ideas and to obtain initial feedback on preliminary agenda items. In the second phase, the expert panel participated in a video discussion to modify or identify new items. Feedback was obtained in a structured format from the panel. The NGT facilitator was tasked with raising discussion points from the first survey that did not surface during the discussion. The FACTS leadership team (R.M.C., P.M.C., and M.A.Z.) integrated the feedback to generate a revised agenda of 52 items for the clarification phase.

Clarification Phase: Iterative Refinement of Research Priorities

During the clarification phase, the agenda items were refined. The expert panel completed a Qualtrics survey reviewing the preliminary list of agenda items with the objective of identifying items with common themes and establishing greater clarity. No items were deleted at this stage, but those with similar themes were combined and streamlined.

Ranking and Voting Phase: Developing Consensus for Research Priorities

The final NGT phase was conducted in 3 stages. First, the expert panel and stakeholders completed an anonymous quantitative survey to establish a priority ranking for agenda items. Items were ranked on a 5-point Likert scale identifying how important each item was for a 5-year research agenda (1 = definitely not a priority, 2 = not a priority, 3 = important but low priority, 4 = should be a priority, and 5 = highest priority). Qualitative feedback was obtained on why items were chosen for inclusion or exclusion. Predetermined consensus for agenda inclusion was defined as more than 70% of the panelists ranking the item as at least a 4 (of 5); agenda exclusion was defined as less than 50% of the panelists ranking the item as at least a 4 (of 5). Second, items not reaching consensus were discussed at a second consortium-wide video meeting (14 items). The expert panel then recommended, defended, and refined these items for inclusion in the agenda. Third, a final round of anonymous voting was conducted on the items that had not reached consensus for inclusion or exclusion in the prior round (n = 12). Based on the final vote, 25 items were included in the semifinal agenda.

Finalizing the Research Agenda: External Expert and Stakeholder Review

These 25 agenda items were then presented for feedback to the 12 stakeholders and a panel of 6 external researchers who were not included in the initial consortium process but have established expertise in the field (eAppendix in the Supplement). Stakeholder ratings were concordant with FACTS expert panel ratings for all agenda items ($r=0.77$) and, with their input, 1 item that had previously been excluded was retained, bringing the total number of research agenda items to 26. External expert feedback was concordant with the last round of internal consortium ranking and suggestions were integrated. Finally, the full agenda was presented at an in-person consortium meeting in October 2018 and ratified by the entire FACTS Consortium.

Results

We identified 26 priority agenda items (with samples of urgent research questions that clarify the items) across 5 major thematic areas. The final list of agenda items and research questions (Tables 1, 2, and 3)^{20,21} represent the areas that the FACTS Consortium defined as being the key priority areas for research and investment for research during the next 5 years.

Discussion

We defined an agenda to guide future research priorities for prevention of pediatric firearm injury. This research agenda is intended to serve as a guide for future research efforts to decrease pediatric death and injury across the thematic areas of: (1) epidemiology, surveillance, and risk and protective factors; (2) primary, secondary, and cross-cutting prevention; (3) policy-related issues; and (4) data enhancement priorities.

Epidemiology and Risk and Protective Factors

More information is needed that characterizes the contextual factors associated with firearm injuries and the associations between firearm availability, storage, and presence and use of a firearm in the home. Research that extends beyond individual-level factors to include risk assessment across multiple ecological levels, with a focus on the intersection between family, peer, and community-level factors, is also needed. Most research beyond the individual level has focused on peers and families,^{22,23} with community factors lacking.^{22,23} The few community studies that have addressed more macro-level issues such as neighborhood socioeconomic variables have not focused on social relationships (eg, social capital and neighborhood monitoring). Only 2 studies have examined the intersection of peer relationships with community macro-level variables.^{22,23} Most research has focused attention on risk factors,^{7,8} while few have examined factors that may reduce the negative effects of risk exposure. Peer firearm carriage, for example may be a risk factor for youth firearm carriage,²⁴ but the role that family firearm safety practices may play in reducing the risk of exposure to peer firearm carriage is unknown.^{22,25}

Primary Prevention

Comprehensive evidence-based programs that address decreasing firearm carriage by children and adolescents and increasing firearm safe storage among caregivers are needed

across the ecological spectrum, including in homes, schools, healthcare settings, and the broader community.⁹ We also identified that the adaptation of evidence-based injury and violence prevention strategies to be applied specifically to decreasing firearm injury risk is a priority. The panel identified engaging caregivers who own firearms as critical to achieve lasting effects and enhance acceptance of prevention strategies focused on decreasing firearm access by children and adolescents, as well as programs focused on increasing safety skills for activities such as hunting. Such intervention development should also consider fidelity and scalability of fire-arm prevention programs, including cost-benefit analyses for intervention research.^{26,27} Finally, research on the outcome of existing and emerging firearm safety technologies (eg, trigger locks and personalized “smart” guns) is lacking specific pediatric outcomes.

Secondary Prevention and Sequelae

The existing literature focuses largely on the prevalence of posttraumatic stress disorder as a consequence of pediatric mass shootings or firearm assault.²⁸⁻³⁷ Attention to prevalence, correlates, and prevention of the full range of physical, mental, educational, and behavioral effects after a pediatric firearm injury, for youths and their families, is needed. For example, the prevalence of depression and substance use, as well as recurrent injury, after firearm injury is poorly described. Rigorous development and validation of prevention strategies to reduce behavioral and physical health consequences after firearm injury is needed. This secondary prevention work must be conducted in a wide range of settings (eg, primary care, families, and schools) and capitalize on innovative technologies (eg, remote therapy and social media) to enhance reach and delivery across socioeconomic and geographic strata. Finally, research on the prevalence, correlates, and prevention of firearm injury sequelae must be conducted across the full range of firearm injury types (eg, not just mass shootings, but also self-harm and peer violence) and the full range of firearm outcomes, including direct victimization and indirect exposure (ie, witnessing violence or hearing about violence).

Policy

Firearm policies remain understudied, particularly as they relate to pediatric outcomes. Among the scant research studying the association between firearm policies and outcomes in children,^{11,38} most studies have tested Child Access Prevention laws or a legislative strength variable that represents how many specific types of firearm laws a state has implemented.³⁹⁻⁵⁰ Almost nothing is known about the association of individual laws with firearm outcomes among pediatric populations, let alone how various firearm laws work synergistically to reduce pediatric morbidity and mortality. It is also critical to consider the extent to which laws vary from state to state and how these variations may affect their reach and implementation. Furthermore, we have found inconsistency in how policies are defined and measured, making direct comparison across studies difficult. This inconsistency is most relevant to policy categories that have differing policy elements across jurisdictions, such as Child Access Prevention laws that differ in the criminal liability imposed (felony or misdemeanor), the criteria for criminal liability being imposed (negligent storage or reckless provision of the gun), and the age of the child with real or potential access to the handgun (<14years in some states, to <18 years in others). An overarching priority is the need to

rigorously define a measure of policy strength that is both specific to pediatric outcomes and considers the complexities noted above. Finally, we need to better understand how firearm policies are implemented, enforced, and communicated to the public so that we can determine how these factors may be associated with fire-arm morbidity and mortality.

Data Enhancement

Firearm research has been constrained by restrictions placed on data collection, availability of data elements, and access to data. Research has also been limited by a lack of linkage between data sources to increase awareness of available data and to allow for a more comprehensive analysis. Augmenting existing data sets with variables associated with firearm injury, and increasing researcher access to existing variables that are currently collected but not easily available, will greatly enhance our ability to study firearm injury outcomes, determine risk factors for firearm outcomes, and inform preventive and therapeutic interventions. Leveraging advances in health information technology to access and link patient-centric clinical data across the spectrum of care (eg, prehospital, hospital, outpatient, and rehabilitation) could improve our understanding of patterns of firearm outcomes among children. The richness of electronic health record data provides a unique opportunity for comparative effectiveness research, which investigates the association between diagnostic and therapeutic interventions and outcomes in heterogeneous patient populations in real-world settings. Integrating such approaches within health care settings, as well as involving data sources not related to health care, would aid in developing a robust understanding of firearm outcomes. Finally, we can maximize current investments by facilitating accessibility of existing and newly collected data in repositories, as is commonly done in other fields.⁵¹

In addition to the research areas noted above, we identified additional considerations for future research. First, research guided by cutting-edge theoretical models used in other injury prevention, public health, and behavioral research is needed to develop unbiased conclusions. Theoretically driven research can inform prevention by identifying modifiable risk and protective factors associated with firearm behavior that interact across socioecologic settings. Second, research that uses rigorous designs, including qualitative data collection, longitudinal data collection, and randomized clinical trial designs, is needed. In parallel, the field requires that more sophisticated and robust data analytic approaches (eg, spatial analysis and growth mixture modeling) be applied to prospective longitudinal data to understand causal relationships. Qualitative data collection is needed to inform quantitative findings, identify new issues to study, and inform the content and implementation of prevention programs. Third, we need research studies with more representative samples. Fourth, we need to improve the measurement and coding of outcomes (conceptual and operational) to capture the complexity of firearm outcomes. Fifth, we need to apply cutting-edge digital tools to advance measurement and intervention to capitalize on advances in technology (eg, mobile health tools), innovative analytic methods (eg, SMS [text messaging], social media, apps, biosensors, and self-quantification technologies), and novel screening methods (eg, self-administered patient portals).

Limitations

Although bias is always a possibility when using consensus techniques, the NGT process is designed to minimize the influence of group dynamics or single individuals on the outcome. This bias was minimized by using a structured process with participation from all consortium experts, and by both open and anonymous feedback via multiple formats (eg, group discussion, qualitative surveys, email and individual feedback). We also included feedback from researchers beyond the field of firearm injury prevention, including firearm enthusiasts and other stakeholders at multiple points during the NGT process. Finally, feedback from an external expert panel that was not engaged in the iterative NGT group process was used to establish a source of external validity to the recommendations included with in this report.

Conclusions

In the mid-1980s after the seminal publication of *Injury in America: A Continuing Health Problem*,⁵² the United States committed to reducing the burden of injury among our population, with substantial investment in injury prevention. Despite declines from the peak of firearm deaths noted in 1994, rates of firearm deaths have been rising recently, with a 44% increase in 2017 relative to 2013.² Today, children and adolescents are more likely to die by a firearm than by any other cause except motor vehicle crash before the end of their teen years.¹ Through our consensus group process, we identified key priority areas of firearm injury prevention research for children and adolescents to help guide increasing foundation and federal investment in this area during the next 5 years. We also posed a range of questions across these priority areas that are answerable with rigorous research methods and analysis used across the health and behavioral sciences, public health, economics, and criminal justice fields. By focusing research and investment in these identified priority areas, investigators and entities that sponsor research can make substantial strides toward decreasing firearm injury and death among US children and adolescents.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Funding/Support: This article was funded through National Institutes of Health/National Institute of Child Health and Human Development grant 1R24HD087149-01A1.

Role of the Funder/Sponsor: The funding source had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

REFERENCES

1. Cunningham RM, Walton MA, Carter PM. The Major causes of death in children and adolescents in the United States. *N Engl J Med.* 2018;379(25): 2468–2475. doi:10.1056/NEJMSr1804754 [PubMed: 30575483]
2. Centers for Disease Control and Prevention. Web-Based injury statistics query and reporting system (WISQARS). <https://www.cdc.gov/injury/wisqars/>. Accessed December 9, 2018.

3. Azrael D, Hepburn L, Hemenway D, Miller M. The stock and flow of US firearms: results from the 2015 National Firearms Survey. *RSF*. 2017;3(5):38–57. doi:10.7758/rsf.2017.3.5.02
4. Ladapo JA, Rodwin BA, Ryan AM, Trasande L, Blustein J. Scientific publications on firearms in youth before and after Congressional action prohibiting federal research funding. *JAMA*. 2013; 310(5):532–534. doi:10.1001/jama.2013.119355 [PubMed: 23925624]
5. Branas CC, Wiebe DJ, Schwab CW, Richmond TS. Getting past the ‘f’ word in federally funded public health research. *Inj Prev*. 2005;11(3):191–191. doi:10.1136/ip.2005.008474 [PubMed: 15933414]
6. Leshner AI, Altevogt BM, Lee AF, McCoy MA, Kelley PW. *Priorities for Research to Reduce the Threat of Firearm-Related Violence*. Washington, DC: National Academies Press; 2013.
7. Schmidt CJ, Rupp L. Risk and protective factors related to youth firearm victimization, perpetration, and suicide: a scoping review and directions for future research. *J BehavMed*. In press.
8. Oliphant SN, Mouch C. A scoping review of the patterns, motives and risk and protective factors for adolescent firearm carriage. *J Behav Med*. In press.
9. Ngo QM, Sigel E. State of the science: a scoping review of primary prevention of firearm injuries among children and adolescents. *J Behav Med*. In press.
10. Ranney M, Karb R. What are the long-term consequences of youth exposure to firearm injury, and how do we prevent them? a scoping review. *J Behav Med*. In press.
11. Zeoli RM, Goldstick J. The association of laws with firearm outcomes among children and adolescents: a scoping review. *J Behav Med*. In press.
12. Delbecq A, Van de Ven A, Gustafson D. *Group Techniques for Program Planning*. Glenview, IL: Scott, Foresman; 1975.
13. Delbecq AL, Van de Ven AH. A group process model for problem identification and program planning. *J Appl Behav Sci*. 1971;7(4):466–492. doi: 10.1177/002188637100700404
14. Van de Ven AH, Delbecq AL. The nominal group as a research instrument for exploratory health studies. *Am J Public Health*. 1972;62(3):337–342. doi:10.2105/AJPH.62.3.337 [PubMed: 5011164]
15. Boddy C The nominal group technique: an aid to brainstorming ideas in research. *Qual Marl Res*. 2012;15(1):6–18. doi:10.1108/13522751211191964
16. Jones J, Hunter D. Consensus methods for medical and health services research. *BMJ*. 1995;311 (7001):376–380. doi:10.1136/bmj.311.7001.376 [PubMed: 7640549]
17. Fink A, Kosceff J, Chassin M, Brook RH. Consensus methods: characteristics and guidelines for use. *Am J Public Health*. 1984;74(9):979–983. doi:10.2105/AJPH.74.9.979 [PubMed: 6380323]
18. Ranney ML, Fletcher J, Alter H, et al.; ACEP Technical Advisory Group on Firearm Injury Research, a Subcommittee of the ACEP Research Committee. A consensus-driven agenda for emergency medicine firearm injury prevention research. *Ann Emerg Med*. 2017;69(2):227–240. doi: 10.1016/j.annemergmed.2016.08.454 [PubMed: 27998625]
19. Brown BB. *Delphi Process: A Methodology Used for the Elicitation of Opinions of Experts*. Santa Monica, CA: RAND Corp; 1968.
20. Aiyer SM, Zimmerman MA, Morrel-Samuels S, Reischl TM. From broken windows to busy streets: a community empowerment perspective. *Health Educ Behav*. 2015;42(2):137–147. doi:10.1177/1090198114558590 [PubMed: 25512073]
21. Wilson JQ, Kelling GL. Broken windows. *Atl Mon*. 1982;(249):29–38.
22. Culyba AJ, Miller E, Ginsburg KR, et al. Adult connection in assault injury prevention among male youth in low-resource urban environments. *J Urban Health*. 2018;95(3):361–371. doi:10.1007/s11524-018-0260-8 [PubMed: 29700679]
23. Dong B, Branas CC, Richmond TS, Morrison CN, Wiebe DJ. Youth’s daily activities and situational triggers of gunshot assault in urban environments. *J Adolesc Health*. 2017;61(6):779–785. doi:10.1016/j.jadohealth.2017.06.018 [PubMed: 28947347]
24. Wilkinson DL. *Guns, Violence, and Identity Among African American and Latino Youth*. El Paso, Texas: LFB Scholarly Publishing; 2003.

25. Kondo MC, South EC, Branas CC, Richmond TS, Wiebe DJ. The association between urban tree cover and gun assault: a case-control and case-crossover study. *Am J Epidemiol.* 2017;186(3): 289–296. doi:10.1093/aje/kwx096 [PubMed: 28481962]
26. Cook PJ, Lawrence BA, Ludwig J, Miller TR. The medical costs of gunshot injuries in the United States. *JAMA.* 1999;282(5):447–454. doi:10.1001/jama.282.5.447 [PubMed: 10442660]
27. Branas CC, Kondo MC, Murphy SM, South EC, Polsky D, MacDonald JM. Urban blight remediation as a cost-beneficial solution to firearm violence. *Am J Public Health.* 2016;106(12):2158–2164. doi:10.2105/AJPH.2016.303434 [PubMed: 27736217]
28. Nader K, Pynoos R, Fairbanks L, Frederick C. Children's PTSD reactions one year after a sniper attack at their school. *Am J Psychiatry.* 1990;147(11): 1526–1530. doi:10.1176/ajp.147.11.1526 [PubMed: 2221168]
29. Pynoos RS, Frederick C, Nader K, et al. Life threat and posttraumatic stress in school-age children. *Arch Gen Psychiatry.* 1987;44(12):1057–1063. doi:10.1001/archpsyc.1987.01800240031005 [PubMed: 3689093]
30. Schwarz ED, Kowalski JM. Malignant memories: PTSD in children and adults after a school shooting. *J Am Acad Child Adolesc Psychiatry.* 1991;30(6):936–944. doi:10.1097/00004583-199111000-00011 [PubMed: 1757443]
31. Bugge I, Dyb G, Stensland SO, Ekeberg Ø, Wentzel-Larsen T, Diseth TH. Physical injury and posttraumatic stress reactions: a study of the survivors of the 2011 shooting massacre on Utøya Island, Norway. *J Psychosom Res.* 2015;79(5):384–390. doi:10.1016/j.jpsychores.2015.09.005 [PubMed: 26526313]
32. Dyb G, Jensen T, Glad KA, Nygaard E, Thoresen S. Early outreach to survivors of the shootings in Norway on the 22nd of July 2011. *Eur J Psychotraumatol.* 2014;5:5. doi:10.3402/ejpt.v5.23523
33. Hafstad GS, Dyb G, Jensen TK, Steinberg AM, Pynoos RS. PTSD prevalence and symptom structure of DSM-5 criteria in adolescents and young adults surviving the 2011 shooting in Norway. *J Affect Disord.* 2014;169:40–46. doi:10.1016/j.jad.2014.06.055 [PubMed: 25129534]
34. Haravuori H, Suomalainen L, Berg N, Kiviruusu O, Marttunen M. Effects of media exposure on adolescents traumatized in a school shooting. *J Trauma Stress.* 2011;24(1):70–77. doi:10.1002/jts.20605 [PubMed: 21268117]
35. Suomalainen L, Haravuori H, Berg N, Kiviruusu O, Marttunen M. A controlled follow-up study of adolescents exposed to a school shooting-psychological consequences after four months. *Eur Psychiatry.* 2011;26(8):490–497. doi:10.1016/j.eurpsy.2010.07.007 [PubMed: 20933371]
36. Thoresen S, Jensen TK, Wentzel-Larsen T, Dyb G. Parents of terror victims: a longitudinal study of parental mental health following the 2011 terrorist attack on Utøya Island. *J Anxiety Disord.* 2016;38: 47–54. doi:10.1016/j.janxdis.2016.01.004 [PubMed: 26812593]
37. Slovak K, Singer M. Gun violence exposure and trauma among rural youth. *Violence Vict.* 2001;16 (4):389–400. doi:10.1891/0886-6708.16.4.389 [PubMed: 11506448]
38. Morrall A. The science of gun policy: a critical synthesis of research evidence on the effects of gun policies in the United States. *Rand Health Q.* 2018; 8(1):5.
39. Cummings P, Grossman DC, Rivara FP, Koepsell TD. State gun safe storage laws and child mortality due to firearms. *JAMA.* 1997;278(13):1084–1086. doi:10.1001/jama.1997.03550130058037 [PubMed: 9315767]
40. DeSimone J, Markowitz S, Xu J. Child access prevention laws and nonfatal gun injuries. *South Econ J.* 2013;80(1):5–25. doi:10.4284/0038-4038-2011.333
41. Gius M. The impact of minimum age and child access prevention laws on firearm-related youth suicides and unintentional deaths. *Soc Sci J.* 2015;52 (2):168–175. doi:10.1016/j.soscij.2015.01.003
42. Hamilton EC, Miller CC III, Cox CS Jr, Lally KP, Austin MT. Variability of child access prevention laws and pediatric firearm injuries. *J Trauma Acute Care Surg.* 2018;84(4):613–619. doi:10.1097/TA.0000000000001786 [PubMed: 29283962]
43. Hepburn L, Azrael D, Miller M, Hemenway D. The effect of child access prevention laws on unintentional child firearm fatalities, 1979–2000. *J Trauma.* 2006;61(2):423–428. doi:10.1097/01.ta.0000226396.51850.fc [PubMed: 16917460]

44. Lee J, Moriarty KP, Tashjian DB, Patterson LA. Guns and states: pediatric firearm injury. *J Trauma Acute Care Surg.* 2013;75(1):50–53. doi:10.1097/TA.0b013e3182999b7a [PubMed: 23778438]
45. Lott J, John R, Whitley JE. Safe-storage gun laws: accidental deaths, suicides, and crime. *J Law Econ.* 2001;44(S2):659–689. doi:10.1086/338346
46. Murnan J, Dake JA, Price JH. Association of selected risk factors with variation in child and adolescent firearm mortality by state. *J Sch Health.* 2004;74(8):335–340. doi:10.1111/j.1746-1561.2004.tb06624.x [PubMed: 15554120]
47. Resnick S, Smith RN, Beard JH, et al. Firearm deaths in America: can we learn from 462,000 lives lost? *Ann Surg.* 2017;266(3):432–440. doi:10.1097/SLA.0000000000002376 [PubMed: 28657951]
48. Ruddell R, Mays GL. Risky behavior, juveniles, guns and unintentional firearms fatalities. *Youth Violence Juv Justice.* 2004;2(4):342–358. doi:10.1177/1541204004267782
49. Safavi A, Rhee P, Pandit V, et al. Children are safer in states with strict firearm laws: a National Inpatient Sample study. *J Trauma Acute Care Surg.* 2014;76(1):146–150. doi:10.1097/TA.0b013e3182ab10fb [PubMed: 24368370]
50. Simonetti JA, Rowhani-Rahbar A, Mills B, Young B, Rivara FP. State firearm legislation and nonfatal firearm injuries. *Am J Public Health.* 2015; 105(8):1703–1709. doi:10.2105/AJPH.2015.302617 [PubMed: 26066935]
51. National Institute of Mental Health. Welcome to the NIMH data archive. <https://dataarchive.nimh.nih.gov/>. Accessed December 16,2018.
52. National Research Council and Institute of Medicine. *Injury in America: A Continuing Health Problem.* Washington, DC: National Academy Press; 1985.

Box.**Broad Categories of Firearm Outcomes Focused Across All Agenda Items****Definition of Firearm Outcomes**

Attitudes toward and knowledge of firearms

Access and storage of firearms

Firearm carriage

Exposure to and witnessing firearm violence

Intentional firearm injury

 Self-inflicted firearm injury (suicide attempts)

 Firearm perpetration and aggression (includes nonpartner and partner)

 Firearm victimization (includes nonpartner and partner)

 Mass shootings, including school shootings

Unintentional (accidental) firearm injury

Areas to Prioritize Research and Investment for Surveillance, Epidemiology, and Risk and Protective Factors of Child and Adolescent Firearm Injury Prevention

Table 1.

Priority Area	Sample of Urgent Research Questions in This Priority Area
Understand recent epidemiologic trends and how demographic factors (race/ethnicity, sex, and socioeconomic status), development stages, and environmental differences (urban vs rural location, neighborhood effect, and culture) are associated with fatal and nonfatal firearm outcomes	<ul style="list-style-type: none"> • How is the epidemiology of nonfatal firearm injuries similar or different from fatal firearm injuries? • What explains underlying racial disparities observed across different types of firearm outcomes? • What underlying factors beyond poverty differentiate different types of firearm injuries across regions of the United States? • What is the role and involvement of girls and rural or sub urban children in firearm injury and firearm culture? • Which risk and protective factors are most salient at which developmental period? • How does developmental stage affect risk and protective factor exposure?
Understand how children and adolescents acquire firearms and patterns of adolescent firearm carriage	<ul style="list-style-type: none"> • What are the different subgroups of adolescents who carry firearms (eg, episodic carriers vs persistent firearm carriers) and what factors differentiate these subtypes? • What factors contribute to initiating and discontinuing firearm carriage? • How do children and adolescents acquire or gain access to firearms? • What is the motivation for acquisition, ownership, and carriage of firearms in adolescence? • How does firearm diversion from the legal market to the illegal market affect child and adolescent firearm outcomes? • What is the concordance or discordance between parents and their children regarding knowledge of firearm access and prior firearm handling among children?
Understand the incidence, patterns, and outcomes associated with defensive firearm use among children, adolescents, and their family members	<ul style="list-style-type: none"> • How often, and in what circumstances, are children and adolescents actively protected by their own self-defensive firearm use or that of someone else (eg, friend, parent, or acquaintance)?
Understand the immediate and long-term costs associated with pediatric firearm outcomes	<ul style="list-style-type: none"> • What are the immediate (eg, health care costs) and long-term (eg, criminal justice, disability, mental health, and societal) costs?
Understand how the availability, storage, and presence or use of a firearm in the home and/or in schools affects child and adolescent firearm outcomes	<ul style="list-style-type: none"> • How are firearms stored in households with children and adolescents? • How many schools in the country have armed adults? • Among households with children, how do the characteristics of those with firearms differ from those without a firearm? • How do the characteristics of firearm-owning households with children that practice safe firearm storage differ from households not practicing safe firearm storage? • How do parents' perceptions and attitudes toward firearm ownership and storage affect risk among children? • How are storage decisions made in homes with children and adolescents?
Understand risk factors and their underlying mechanisms across ecological levels, especially those that extend beyond the individual level to include community, school, family, and peer factors	<ul style="list-style-type: none"> • What are the risks across multiple ecological levels, with a focus on understudied family-level (including adverse childhood experiences and family intimate partner violence), school-level, and community-level factors? • How does the socialization of children in a firearm culture (eg, hunting and media) and/or exposure to firearm violence (eg, neighborhood violence, violence in the home environment, and media portrayals of violence) positively or negatively influence outcomes? • What event, situational, and contextual factors, including social network and contagion models, are associated with firearm outcomes?
Understand protective factors for firearm outcomes and their underlying mechanisms across all individual and socioeconomic levels (community, school, family, and peers)	<ul style="list-style-type: none"> • What are key protective factors across ecological levels for child and adolescent firearm outcomes (before and after a firearm injury), and how do those factors interact with effects of risk?

Table 2.

Prevention and Crosscutting Items

Priority Area	Sample Urgent Research Questions in This Priority
Areas to Prioritize Research and Investment for the Primary Prevention of Firearm Injury Among Children and Adolescents	
Understand the most effective screening approaches for children, adolescents, and their families to identify those who are at risk for firearm outcomes across health care settings and non-health care settings	<ul style="list-style-type: none"> • What are the best screening tools for health care professionals and other practitioners to identify when there are firearms in the home that are not stored safely? • What is the optimal method and type of screening for youth at risk for firearm outcomes in schools? • What are the best screening tools for health care professionals and other practitioners to identify children and adolescents at risk for firearm outcomes? • What types of training are needed among health care professionals and/or others to increase screening, comfort discussing firearms, and effective delivery of interventions to address firearm outcomes in health care and other settings? • How should screening for safe storage be implemented as part of standard practice in health care and other settings? • What are caregiver perceptions of screening around firearm safety and safe storage?
Examine the effectiveness of individual, interpersonal, and environmental school-based primary prevention strategies to reduce firearm outcomes	<ul style="list-style-type: none"> • How effective are school-based violence prevention programs at reducing firearm carriage and use (among middle school-aged and high school-aged youths) and firearm access, firearm play, and unintentional firearm injury (among elementary school-aged youths)? • How should parents be involved in school-based programs to increase understanding of children's risk of firearm injury (eg, mismatch in parent perception and child behavior)? • How effective are school-based programs for reducing firearm suicide risk? • What are the effects of (armed) school guards and metal detectors on firearm outcomes?
Examine the effectiveness of health care-focused primary prevention strategies for children, adolescents, and their families to reduce firearm outcomes	<ul style="list-style-type: none"> • Are hospital-based violence prevention programs (ie, primary prevention programs) effective in preventing firearm outcomes? • What are the most effective methods for conducting lethal means counseling (ie, fatal means of killing oneself such as a firearm) in health care settings? • What is the most effective means of engaging health care professionals to capitalize on Extreme Risk Protection Orders (in states with Extreme Risk Protection Orders policies) as a primary prevention strategy for preventing firearm outcomes among children and adolescents? • What is the most effective way to counsel caregivers to prevent children and adolescents' access to firearms among individuals who do not own firearms? • What are the effects on firearm outcome of metal detectors in health care settings?
Examine the effectiveness of community-based primary prevention strategies for preventing or decreasing firearm outcomes among children, adolescents, and their families	<ul style="list-style-type: none"> • Do firearm safety educational programs for children and adolescents and their families improve their safe handling and/or avoidance of firearms and decrease unintentional shootings? • What programs are effective in changing attitudes and addressing motives for carrying and use of firearms among children and adolescents at risk of perpetrating firearm assault or homicide? • What neighborhood environmental design strategies could be implemented to prevent firearm outcomes? • How can media and social media be leveraged to reduce firearm outcomes? How do media and social media increase firearm outcomes? • How can police enforcement help prevent firearm outcomes? What innovative methods of policing (eg, community policing) are effective at decreasing firearm outcomes? • What are the key components of community interventions across the social ecology to increase safe storage and decrease weapon carriage and use by children and adolescents?
Examine the effectiveness of primary prevention strategies, including safe storage, to prevent or reduce child and adolescent firearm outcomes in the home environment	<ul style="list-style-type: none"> • What support do firearm-owning caregivers need to implement change in their homes regarding the safe storage of firearms? • What adolescent-focused firearm safety training is most effective for hunting and sports? • What is the most effective way to counsel caregivers to prevent children and adolescents' access to firearms among individuals who do not own firearms? • How can prevention of family violence and intimate partner violence help reduce child and adolescent firearm outcomes?
Examine the efficacy of existing and new firearm safety technologies (eg, higher pressure triggers and radio-frequency identification safeguards) to prevent child and adolescent firearm outcomes and understand barriers to uptake of technologies among caregivers	<ul style="list-style-type: none"> • What is the effectiveness of technology to "personalize" firearms? What is the effect of this technology on firearm outcomes? Can technology be retrofitted to existing firearms? What is the price point at which consumers are willing to pay for such technology? • Does implementation of "smart" firearm technology lead to decreases in firearm outcomes of injury and death? • How can caregivers be motivated or incentivized to use a new technology that makes firearms safer? • How could we evaluate efficacy of new firearm technology for preventing firearm outcomes? • How do we partner with firearm manufacturers to implement these technologies in their products?

<p>Priority Area</p>	<p>Sample Urgent Research Questions in This Priority</p> <ul style="list-style-type: none"> • How well do these firearm technologies prevent firearm outcomes for children and adolescents? • How do we address concerns among firearm owners about firearm safety technology?
<p>Areas to Prioritize Research and Investment for the Prevention of Secondary and Long-term Health Consequences of Firearm Outcomes Among Children and Adolescents</p> <p>Examine the patterns of physical, socioemotional, educational, and mental health sequelae that occur among children, adolescents, and their families after experiencing or witnessing a fatal or nonfatal firearm injury</p>	<ul style="list-style-type: none"> • What is the effect of a firearm injury on family function? • What are the mental and physical health sequelae for the parents after a pediatric firearm injury? • How do patterns of family function and physical and mental health sequelae after a pediatric firearm injury differ across urban, suburban, and rural contexts? • What are mediating and moderating factors for mental health (eg, posttraumatic stress disorder), injury (eg, recidivism), and behavioral (eg, other risky behaviors) sequelae that occur after a pediatric firearm injury? • What are the patterns and determinants of recidivism or repeat negative firearm outcomes after a firearm injury or cumulative exposures of violence? • What interventions improve child, adolescent, family, and community resilience after a firearm injury? • What are the mental and behavioral health effects of school shootings on youths in the exposed schools, in the exposed community, and nationally across school-age children and adolescents? • What are social media mediators, moderators, and predictors of negative sequelae of a pediatric firearm injury?
<p>Examine health care-based interventions for children and adolescents who have experienced or witnessed a firearm injury to prevent (or reduce) subsequent firearm outcomes including firearm injury recidivism and mental health, socioemotional, and educational outcomes</p>	<ul style="list-style-type: none"> • What interventions are effective in the period immediately after the firearm injury, to address and mitigate negative outcomes (posttraumatic stress disorder, anxiety, depression, recurrent self-harm, substance use, and risky behavior) and increase resilience and quality of life? • How can these behavioral interventions be incorporated into trauma-informed care? • What are the interventions that most effectively reduce recidivism and retaliation by those injured by firearm or peers immediately after a firearm injury? • What are the most acceptable, feasible, and effective intervention modalities (eg, peer supports, tele-health) in the period immediately after the firearm injury? • What interventions are effective at preventing long-term negative sequelae among peers, family, and friends who witness or are exposed to firearm injury? • What are the best methods for addressing lethal means access in health care settings by health care professionals after firearm injury (including after suicide attempt, unintentional injury, and intentional youth, peer, and dating firearm violence)?
<p>Examine school-based response and interventions for children and adolescents who have experienced or witnessed a firearm injury to prevent (or reduce) subsequent mental health, socioemotional, and educational problems</p>	<ul style="list-style-type: none"> • After a school shooting (an individual person shot or school-wide shooting), what intervention is most effective at mitigating long-term consequences among both youth and staff, and what is the proper delivery modality (eg, by teachers, support staff, superintendents, or outside interventionists)? • What mass casualty preparedness issues are specific to school settings? • How do we most effectively prepare to reduce mass casualties specific to school shootings? • What are the effects of arming teachers? Can simulation training provide evidence to guide the efficacy of arming teachers as an intervention? • What classroom or school-wide interventions increase resilience after shooting or a suicide by firearm in a school?
<p>Examine community-based interventions including environmental design changes after a shooting to prevent or reduce subsequent firearm outcomes</p>	<ul style="list-style-type: none"> • What community-based interventions (eg, delivered by churches or community organizations) are most effective at reducing future injury and other negative sequelae after a pediatric firearm injury or firearm suicide or shooting? • How do community models of mediation and reconciliation interrupt or reduce firearm outcomes? • How does the “busy streets theory”²⁰ or the converse “broken windows theory”²¹ apply to reducing firearm outcomes? • How can police interventions use “hot spot” policing (identifying clusters or patterns of shootings) to interrupt firearm violence in a community? • Are there interventions that involve environmental design changes (eg, greening of high shooting areas) that can decrease future firearm outcomes in a community, and what is the best method for implementing them?
<p>Areas to Prioritize Research and Investment that Are Crosscutting Across Primary and Secondary Prevention of Firearm Injury Among Children and Adolescents</p> <p>Examine the relative costs and benefits of primary and secondary prevention strategies</p>	<ul style="list-style-type: none"> • What are the costs and benefits of firearm interventions? For example: <ul style="list-style-type: none"> • School interventions such as school drills? • Health care screening and intervention costs? • Cost benefit of environmental interventions (greening)? • Costs of secondary prevention of recidivism after injury? • What are the cost benefits of security services at schools, hospitals, and other potential places where children and adolescents frequently visit on a daily basis? • How effective are existing interventions at reducing specific firearm outcomes? What is the efficacy of the application of other evidence-based interventions (eg, for suicide, youth violence,

Priority Area	Sample Urgent Research Questions in This Priority
<p>posttraumatic stress disorder, prevention and treatment, home safety, and police interventions) to evaluate their effectiveness at reducing child and adolescent firearm-specific outcomes</p>	<p>firearm outcomes?</p> <ul style="list-style-type: none"> • Are current hospital-based violence prevention programs effective at reducing subsequent firearm violence, injury, and crime for children and adolescents? • What promising existing children and adolescents violence prevention programs might be applied to reduce firearm outcomes across settings (eg, primary care, schools, and criminal justice)? • How can firearm safety and lethal means counseling be incorporated into other suicide prevention programs and other adolescent firearm activities such as 4H, scouting, hunting, and safety training classes? • How can or should lethal means safety counseling be adapted for use with adolescents? How is the messaging similar or different when the adolescent is the user of the firearm (eg, hunting or sports) vs not? • Does increased police enforcement presence or proactive efforts (directed patrol and stop and question or frisk) reduce firearm outcomes? • How can police best partner with community groups on focused deterrence (group violence) programs? • What are the most effective criminal justice responses to youths who have committed gun violence with respect to sentencing, rehabilitation, and reconciliation?

Table 3.

Policy and Data Enhancement Items

Priority Area	Sample Urgent Research Questions in This Priority
Areas to Prioritize Research and Investment in Examining Policies That Affect Firearm Injury Among Children and Adolescents	
Develop a uniform coding system for firearm-related policies, particularly as they relate to their effect on child and adolescent outcomes	<ul style="list-style-type: none"> • What are important differences in policy provisions and how do they influence policy effectiveness? • What is the relative importance of different policy strictness factors as they relate to child and adolescent outcomes?
Understand the effect of existing adult-focused and child-focused firearm policies on child and adolescent firearm outcomes	<ul style="list-style-type: none"> • Do laws specifying the implementation of firearm and ammunition purchase restrictions affect firearm-related morbidity and mortality among children? For example: <ul style="list-style-type: none"> • Permit to purchase licensing laws • Comprehensive background check laws • Ammunition background checks • Are the standards required for concealed carry in a state associated with firearm-related morbidity and mortality among children? • Do extreme risk protection orders reduce firearm-related morbidity and mortality among children? • How do various laws aimed at reducing violence, including those that are not firearm specific (eg, juvenile justice record policies), affect child and adolescent firearm outcomes?
Understand how firearm policies may work synergistically to reduce the risk of child and adolescent firearm outcomes	<ul style="list-style-type: none"> • How are laws restricting who may purchase a firearm and laws specifying the need for a background check (eg, minimum age and permit to purchase) synergistic?
Understand how firearm policies that may be protective for children and adolescents are implemented, enforced, and communicated to the public	<ul style="list-style-type: none"> • Current firearm policy studies generally do not have good measures of policy implementation; how would pairing an implementation study with a policy analysis (provided both are designed and match well) aid understanding in the field? • How does differential use (ie, entering of records) of the background check system (National Instant Criminal Background Check System) across states affect child firearm outcomes? • How are firearm policy measures affecting children and adolescents (eg, Child Access Protection laws) communicated to the public? What are associated measures of implementation for such laws? • Background check laws: some states are better at entering records into the background check system (National Instant Criminal Background Check System) than others; does this affect firearm-related morbidity/mortality for children? • Child Access Protection laws: are these laws communicated to the public? Is it possible to conceptualize a measure of implementation?
Areas to Prioritize Research and Investment in Data Enhancement of Firearm Injury Among Children and Adolescents	
Augment existing large national and/or local or regional data sets with additional variables, as well as increase researcher access to existing variables within such data sets	<ul style="list-style-type: none"> • What is the best way to encourage and incentivize researchers to incorporate key variables related to firearm outcomes in other ongoing research to allow for the comparison of firearm outcomes with other non-firearm outcomes?
Capitalize on technological advances to link current emergency medical services, medical examiner, hospital system, census, geographic information systems, and other data to develop a robust surveillance system for firearm morbidity and mortality	<ul style="list-style-type: none"> • What is the optimal public health surveillance system for firearm injuries and death that avoids substantial time lag?
Improve data availability and accessibility by creating centralized data repositories that allow for the analysis and cross-linking of data sets	<ul style="list-style-type: none"> • What is the best way to incentivize researchers to make existing data sets (with proper permissions) available to other researchers for testing new hypotheses?