




BMJ Open Building community resilience to prevent and mitigate community impact of gun violence: conceptual framework and intervention design

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ABSTRACT

Introduction The USA has the highest rate of community gun violence of any developed democracy. There is an urgent need to develop feasible, scalable and community-led interventions that mitigate incident gun violence and its associated health impacts. Our community-academic research team received National Institutes of Health funding to design a community-led intervention that mitigates the health impacts of living in communities with high rates of gun violence.

Methods and analysis We adapted ‘Building Resilience to Disasters’, a conceptual framework for natural disaster preparedness, to guide actions of multiple sectors and the broader community to respond to the man-made disaster of gun violence. Using this framework, we will identify existing community assets to be building blocks of future community-led interventions. To identify existing community assets, we will conduct social network and spatial analyses of the gun violence episodes in our community and use these analyses to identify people and neighbourhood blocks that have been successful in avoiding gun violence. We will conduct qualitative interviews among a sample of individuals in the network that have avoided violence (n=45) and those living or working on blocks that have not been a location of victimisation (n=45) to identify existing assets. Lastly, we will use community-based system dynamics modelling processes to create a computer simulation of the community-level contributors and mitigators of the effects of gun violence that incorporates local population-based data for calibration. We will engage a multistakeholder group and use themes from the qualitative interviews and the computer simulation to identify feasible community-led interventions.

Ethics and dissemination The Human Investigation Committee at Yale University School of Medicine (#2000022360) granted study approval. We will disseminate study findings through peer-reviewed publications and academic and community presentations. The qualitative interview guides, system dynamics model and group model building scripts will be shared broadly.

Strengths and limitations of this study

- We use an assets-based, community resilience framework to understand and address a complex, socially involved problem, such as community gun violence.
- We use systems science informed by a community-engaged, participatory approach to elicit community assets that might be protective from gun violence.
- We use a community-engaged design process throughout to increase the likelihood of intervention sustainability.
- System dynamics modelling allows for interventions to be tested and evaluated for impact in simulation before being implemented in reality.
- The system dynamics model can be adapted for use by other communities that are also looking for approaches to mitigate gun violence.

INTRODUCTION

Community gun violence killed more than 28 000 people in the USA in 2017–2018, with racial and ethnic minorities disproportionately affected.¹ These deaths have collateral impact, as families and neighbours of these victims and perpetrators are also affected, amplifying its long-term health impacts.^{2–4} Living in violence-endemic neighbourhoods is associated with chronic stress, poor cognitive performance and poor health outcomes.^{5–7} In a national study of adolescents, 38% reported witnessing community violence, and 7% and 10% of those who witnessed community violence were diagnosed with post-traumatic stress disorder and depression, respectively.⁸

In addition to the negative health effects among community members, violence is strongly associated with extreme socioeconomic disadvantage and, in turn, exacerbates these disadvantages, creating a vicious

cycle. Community-level risk factors for gun violence include poverty,^{9–11} unemployment and housing environments.^{12–13} The association between these risk factors and violence is mediated by social cohesion and willingness to intervene in neighbourhood events—broadly conceived as the collective efficacy¹⁴ of a community—which is itself negatively impacted by community violence.¹⁵ Exposure to violence is associated with lower high school graduation rates and lower rates of college attendance,¹⁶ cementing long-term economic disadvantage.¹⁷ Compounding the negative health effects of exposure to violence, aggressive policing tactics often used in communities with high levels of violent crime have a negative impact on test scores among African-American boys,¹⁸ while violent victimisation increases the likelihood of subsequent gun-carrying behaviours.¹⁹ As such, because the community environment is inextricably linked to the incidence and effects of community gun violence, using a community-based approach is necessary to curb the incidence and effects of gun violence.

However, few studies have rigorously tested using an experimental design interventions to prevent and/or mitigate the broader health consequences of gun violence. The Cardiff Model is one notable example in the UK that uses real-time data to identify physical locations where violence occurs and engages multisector partners to develop interventions such as improving street lighting to reduce violence in these areas.^{20–21} There are also a few intervention studies that are focused on modifying the physical attributes of neighbourhoods. Perhaps the strongest existing evidence supporting neighbourhood interventions that reduce gun violence and improve community resident health is related to greening urban landscape. A recent cluster randomised study in Philadelphia found that the greening of urban lots was associated with reduced crime and violence and improved mental well-being of community members.^{22–23} Some evidence also suggests that reducing alcohol availability²⁴ and improving street lighting can reduce neighbourhood violent crimes.²⁵ These interventions are promising, but more study is needed. We do not yet know which of these interventions is the most effective or cost-effective. Emerging evidence also suggests that other potential, untapped community-level social factors—such as neighbourhood cohesion—that could influence the incidence or effects of gun violence but more research is needed.^{12–26–29}

One underappreciated path to identifying effective interventions that reduce community exposure to gun violence is designing and implementing them in partnership with community leaders and residents of violence-endemic neighbourhoods. Emerging literature suggests community ownership of interventions and partnerships are important for sustaining reductions in gun violence.^{30–31} In 2011, we convened a multisector partnership of city leaders, community members and academic researchers in response to a marked increase in community gun violence in New Haven, Connecticut.

We conducted a study to determine if it were possible to activate community members and local officials to engage in a community-based approach to respond to gun violence.³² Our results indicated that community members anticipate community gun violence and take action to mitigate the health impacts of community gun violence: parents were creating action plans with their children in the event of finding a stray gun or witnessing gun violence and building community coalitions to check in with neighbours after a shooting. Furthermore, those that reported higher rates of neighbourhood social cohesion and collective efficacy had lower exposure to gun violence, even after adjusting for sociodemographics, home ownership status, employment status and number of years living in the community.³²

We received funding from the National Institutes of Minority Health and Disparities (1R01MD010403-01) to design an assets-based, community-led intervention to reduce gun violence that engages community members and that mitigates the health impacts of living in communities with high rates of gun violence. In this paper, we describe the history behind our community–academic partnership, the conceptual framework on which this work is grounded, and the methodology by which we will identify community assets and design an intervention. Our hypothesis is that a research process that uses an assets-based framework and that includes community partners from multiple sectors will lead to novel community-led interventions to prevent and mitigate the effects of gun violence for future development and testing.

CONCEPTUAL FRAMEWORK

We embed this study protocol in a disaster preparedness framework that focuses on strengthening community assets and that addresses both the psychosocial and logistical aspects of potential responses to gun violence. Our group chose to adapt *Building Resilience to Disasters*, a framework developed for disaster preparedness by RAND, to guide multiple sectors and the broader community in response to natural disasters (figure 1).³³ Our community–academic partnership recognised the strong parallels between a natural disaster and that of a ‘chronic, man-made disaster’ like gun violence, in terms of the immediate and long-term trauma and the importance of a community-led response.

The framework identifies eight key levers of community resilience (wellness, access, education, engagement, self-sufficiency, partnership, quality and access) which, in turn, strengthen five core components of community resilience (red boxes). Each lever was adapted for preventing or mitigating the effects of gun violence: wellness was defined as assets that promote social and economic well-being (eg, relationships with neighbours or family; barber shops or churches; and parks); access was defined as individuals’ access to resources that promote physical, mental and emotional well-being (eg, access to

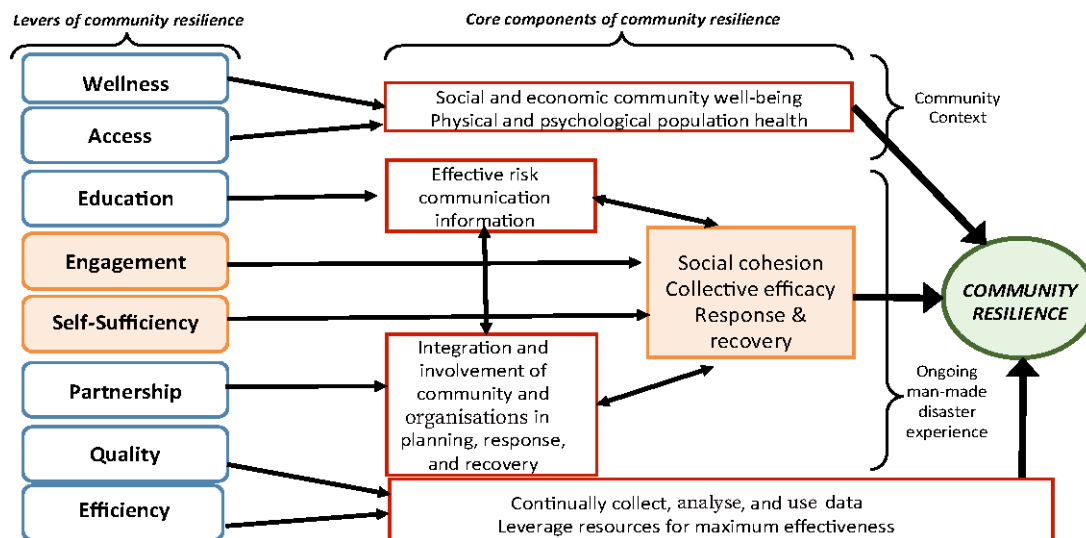


Figure 1 Building resilience to disasters, a framework from RAND for natural disaster and adapted for man-made disaster like gun violence.

a physician or therapist; a neighbour texting tree; and having a mentor); education addresses communication around guns; engagement reflects social cohesion within community and with other organisations; self-sufficiency is the ability of a community member to take action in the community to create a safe and orderly environment (eg, self-policing, starting a block watch and church organises a gun buy back); partnerships refers to developing strong connections between individuals in planning response and recovery around gun violence; quality is associated with the use or promotion of data collection, analysis and utilisation for gun violence prevention or response activities; and lastly, efficiency is the efficient use of data for gun violence prevention and responsiveness. In particular, we chose this framework given that the levers of engagement and self-sufficiency (highlighted in orange, figure 1) spoke to the role that community members had in building the core component of social cohesion, which is critical to community resilience. This framework focuses on strengthening these eight levers for preparedness, thereby improving day-to-day systems and fortifying the positive relationships that allow a community to anticipate and respond effectively to community gun violence. Responsibility for preparedness is shared across communities and all levels of government, with members of the public as full and active participants in the prevention of and response to gun violence.

METHODS

Overview

Over the course of 3 years, we will use a set of novel and complementary methods to identify and characterise existing community assets that build community resilience and may also mitigate the incidence and impact of gun violence episodes in our community (figure 2). Specifically, we will use social network analyses, spatial analyses (year 1), qualitative interviews (year 2) and system

dynamics modelling (year 3) to first identify community assets, or protective factors, and then model the effects of strengthening these assets on the anticipated rates and effects of gun violence.

Social network analyses map and measure the number and strength of relationships among people and have shown that a small proportion of individuals in any given community are involved in gun violence.³⁴ Spatial analyses, where the unit of analysis is a neighbourhood block, have shown that gun violence takes place consistently on only a few blocks within cities. Both of these analyses will be helpful in identifying what factors put people and places within communities at risk for future gun violence and also which ones are protective. We will use these analyses to identify what we call ‘positive deviants’: people, organisations and neighbourhood blocks that have been successful in avoiding gun violence despite being high risk based on sociodemographic characteristics. We will then conduct qualitative interviews among a sample of these people and individuals living or working on these blocks to identify existing assets to prevent or mitigate the effects of gun violence. Lastly, we use a community-engaged approach to design a system dynamics simulation model

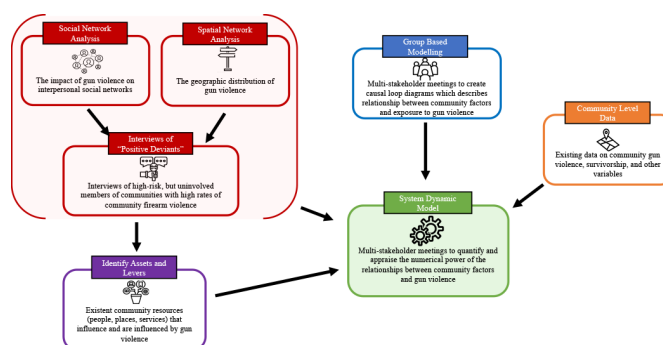


Figure 2 Incorporation of data to create a system dynamics model to identify resilience-building community assets.

of the community-level contributors and mitigators of the effects of gun violence in New Haven, Connecticut. This simulation will incorporate a community-generated causal loop diagram, data from the social network and spatial analyses, local population-based data and themes from the qualitative interviews in its design. We will use the model to test, *in silico*, the anticipated effects of feasible community-led interventions on the incidence and effects of gun violence.

Social network analysis of victims and perpetrators of gun violence

We will first construct the social network of gun violence in New Haven, Connecticut, thus allowing us to better understand individual and network factors that put individuals at risk for victimisation. Victims and perpetrators of gun violence concentrate within small and identifiable social networks of largely minority men. For instance, nearly 70% of shootings in Chicago occurred within networks constituting less than 6% of the city's population.^{35 36}

We will conduct a social network analysis using disaggregated arrest records and police data on gun violence from 2011 to 2016 and determine the distribution of gunshot victimisation in New Haven, Connecticut, within social networks. We will then model gun violence victimisation using a random forest model, in which the probability of future victimisation depends on individual-level attributes, the history of past victimisations and the history of past victimisations among each individual's network peers.^{34 37–39} The random forest model will be used to estimate the probability that each individual will be victimised in the future, given individual and network factors.

We will use these data in two ways; first, we will identify individuals within the social network of gun violence who have had a high risk of victimisation, given individual, network and neighbourhood risk factors but have not been victimised (ie, positive deviants). These individuals will be approached to participate in qualitative in-depth interviews to elicit community assets they used to remain safe from gun violence. Second, data from the social network analysis will be used to initialise relevant rates and parameters in the system dynamics model simulating the incidence and effects of gun violence in New Haven, Connecticut. We will also be able to integrate the social network with the system dynamics model.

Neighbourhood block-level spatial analysis of gun violence events

Next, we will conduct a spatial analysis to identify blocks within the six high-violence neighbourhoods of New Haven that are at high risk for being a location for a gun violence event but have not yet been a location of such an event. Data from Boston indicate that 50% of shootings occurred on less than 3% of all city streets.³⁶ We will use a point-process model to identify neighbourhood blocks that have a lower or higher incidence of gun violence than would be expected based on socioeconomic and

demographic factors and the level of gun violence in surrounding blocks.

We will analyse the location and timing of gunshot victimisations in New Haven, Connecticut, from 2011 to 2016 using a two-component spatio-temporal intensity model.⁴⁰ In the first component, we model the count of victimisations in each census block group as a function of neighbourhood-level socioeconomic indicators (eg, proportion of households with income below 50% of the poverty threshold; number of evictions) and demographic indicators (eg, population aged 15–34 years). The second component is a 'self-exciting' process, which allows for victimisation events to temporarily increase the probability of secondary victimisation events in spatial and temporal proximity. Based on the fitted model, we will simulate the frequency of victimisations in each census block group and identify the block groups with fewer victimisations than expected (ie, positive deviants). Like the social network analysis, we will use these data in two ways; first, we will identify neighbourhood blocks within the six high-violence neighbourhoods of New Haven, Connecticut, that are expected to have high risk for incident gun violence but where no shootings have occurred. We will approach individuals who live and/or work on these blocks to participate in qualitative interviews. Second, we will use these data to initialise parameters of the system dynamics model.

Qualitative in-depth interviews of 'positive deviants'

A 'positive deviance' approach is an approach to behavioural and social change based on the observation that in any community there are people whose uncommon but successful behaviours or strategies enable them to find better solutions to a problem than their peers, despite facing similar challenges and having no extra resources or knowledge than their peers.⁴¹ A positive deviance approach has been applied successfully to complex problems, such as malnourishment in developing countries and hospital quality improvement projects targeting coronary heart disease⁴¹ but not to community gun violence. Our hypothesis is that these individuals or people who live or work on these neighbourhood blocks may have leveraged community assets that have been effective in preventing gun violence.

We will conduct in-depth interviews among 'positive deviant' individuals identified in our social network and spatial analyses to elicit factors protective against gun violence. Individuals will be selected for in-depth interview based on identified positive deviant factors, such as not having personal involvement in gun violence, despite exposure to gun violence and being connected to people who have been involved in gun violence identified in our social network map (n=45). We will also conduct interviews among individuals living on the 'positive deviant' blocks identified in our spatial analysis (n=45). We will use a combined inductive and deductive coding strategy for the network-based and block-based interviews, using our community resilience conceptual framework for

categorisation of factors by the eight levers and identify each lever as an individual, organisational or built environment asset.⁴² Because the community members of our research team are especially interested in interventions that build on community engagement and self-sufficiency, we will probe especially for assets that are community led. The interviews will address these questions, including: ‘If you have friends who have experienced violence or victimization, what do you think might be different between you and them?’; ‘How have you avoided getting involved in gun violence?’; and ‘Why hasn’t this block had a shooting?’ (see online supplemental files appendices S1 and S2).

System dynamics modelling to identify effective community-led interventions

Recognising that the community resilience conceptual model is more complex than depicted—levers interact with each other and with other community factors to contribute to the outcome—we will use a participatory process to better understand how these levers from the resilience model, and potentially other factors, together influence the community-wide impact of gun violence. Specifically, we will use group model building, a collaborative, participatory method for involving diverse stakeholders in the design of a system dynamics model.⁴³ Group model building has been used to explore the key determinants of community violence and has been useful, in particular, for bridging different racial experiences of gun violence.⁴⁴ System dynamics modelling is a method that describes dynamic, multilevel, linear and non-linear processes required so that solutions to challenging social problems like gun violence can be identified.^{45–51}

We will assemble a multisector group to engage in a series of these group model building sessions to create a causal loop diagram. A causal loop diagram is a visualisation of how different variables in a system are inter-related. The group will include stakeholders that represent each lever of the community resilience framework, including but not limited to police, community leaders, educators, health professionals, researchers and neighbourhood residents. Together, participants will design a causal loop diagram that describes how community factors from all eight levers in the community resilience framework influence each other and influence exposure to gun violence. The group model building sessions will be overseen by facilitators, a process coach, an assistant modeller and a community research assistant who will provide feedback and reflection on the interactions that occurred during the modelling sessions. This additional layer of feedback and reflection will provide additional insight to which we can further adapt the model.

We will use the resulting causal loop diagram to inform the design of a system dynamics model. Local data on gun violence rates, data from social network and spatial analyses, community-based assets related to the eight levers of community resilience and rates of negative health outcomes related to living in violence-endemic

neighbourhoods will be further used to calibrate and validate the model.^{32 52 53} We may link the social network into the system dynamics model, creating a hybrid model, if it is expected to significantly refine the output. We will review how well the structure of the system dynamics model reflects codes and themes elicited from the qualitative interviews (ie, construct validity). We will iteratively present this model to our community stakeholder group for additional refinement and modification.

The model will then be used to simulate the impact of an intervention or set of interventions aimed at preventing and mitigating health outcomes related to exposure to community gun violence. Hypothesised multicomponent community interventions will be simulated with greater or fewer of the actual components to identify the minimum set(s) of interventions required to achieve desired outcomes. We provide examples of potential neighbourhood interventions categorised by the eight resilience levers (table 1). Intervention(s) that are considered feasible by community stakeholders and effective in the simulation model will be the basis of future interventions that we will implement and test.

Patient/public involvement

Community members were involved in grant writing and budgeting and will be involved in hiring team members, study design, implementation, analysis and dissemination. Specifically, community research partners will reflect on the high-risk and low-risk areas for gun violence in New Haven and will select the areas from which we should recruit participants for qualitative analyses. For the qualitative study, community research partners will be involved in designing the interview guide, administering interviews, analysis and coding. Finally, community stakeholders will be engaged in the group model building sessions with the aim of codesigning the system dynamics model. Findings will be regularly presented during monthly meetings of our community steering committee. Coauthorship is determined ahead of time and includes community members. Any decision making throughout the course of the study is guided by our community steering committee.

ETHICS AND DISSEMINATION

The Human Investigation Committee at Yale University School of Medicine (#2000022360) granted study approval. We will disseminate study findings through peer-reviewed publications and academic and community presentations. The qualitative interview guides, system dynamics modelling and group model building scripts will be shared broadly.

DISCUSSION

Our academic–community partnership has uniquely framed gun violence as a chronic, man-made disaster and is seeking solutions in a strengths-based, disaster

Table 1 Examples of possible neighbourhood interventions categorised by resilience levers

Lever	Definition	Examples of related neighbourhood interventions
Wellness	Promote preincident and postincident population health, including behavioural health.	<ul style="list-style-type: none"> ▶ Creating green spaces from vacant lots to improve safety and visual appeal of neighbourhood. ▶ Develop public health messaging to promote healthy lifestyles and bolster psychological wellness.
Access	Ensure access to high-quality health, behavioural health and social services.	<ul style="list-style-type: none"> ▶ Work with local community health centres to have extended hours for mental health services after an episode of gun violence. ▶ Provide psychological first aid immediately to community members in their homes after gun violence.
Education	Ensure ongoing information to the public about preparedness, risks and resources before, during and after a disaster.	<ul style="list-style-type: none"> ▶ Educate children at local schools through theatre about gun safety. ▶ Train community partners in proper risk communication and response to techniques to gun violence.
Engagement	Promote participatory decision making in planning, response and recovery activities.	<ul style="list-style-type: none"> ▶ Engage local business owners, such as liquor store owners, in violence prevention efforts. ▶ Develop a community plan for re-establishing social routines and relationships and reclaiming the space of the gun violence event.
Self-sufficiency	Enable and support individuals and communities to assume responsibility for their preparedness.	<ul style="list-style-type: none"> ▶ Promote programmes that recognise the vital role community members can play as ‘first responders’ to gun violence. ▶ Establish a phone or text tree that gets activated directly after an event of gun violence.
Partnership	Develop strong partnerships within and between government and non-governmental organisations (NGOs).	<ul style="list-style-type: none"> ▶ Work with local police to develop texting programs to facilitate information exchange about events of gun violence. ▶ Determine what social networks exist and how to activate them during episodes of gun violence and to prevent gun violence.
Quality	Collect, analyse and use data on building community resilience.	<ul style="list-style-type: none"> ▶ Collect and monitor measures of social networks, community resilience and gun violence to assess baseline levels and change over time. ▶ Share resilience and recovery-related data and lessons to improve resilience-building activities.
Efficiency	Leverage resources for multiple use and maximum effectiveness.	<ul style="list-style-type: none"> ▶ Provide funding to NGOs to include planning response activities for gun violence. ▶ Develop plans to assess community needs for resource allocation at the onset of incident gun violence.

preparedness model that builds community resilience in order to mitigate the long-term health effects of community gun violence.²⁷ Our approach is based on addressing the community context within which gun violence persists, builds on community strengths, addresses all community members—rather than solely perpetrators or victims—and allows for rigorous and structured planning and evaluation. Furthermore, we will integrate data from formal social network and spatial analyses into a system dynamics model to identify feasible and effective community-led interventions. To the best of our knowledge, this will be one of the first times a formal application of systems science will contribute to interventions that build community resilience to mitigate the effects of community gun violence.

Also unique to our approach is identifying community assets that can be leveraged to mitigate the impacts of gun violence and related health sequelae. Rarely have gun violence prevention or mitigation strategies been designed to strengthen the existing assets within neighbourhoods.

To date, the majority of gun violence prevention efforts are focused on risk reduction, through gun buy backs and enforcement, illicit drug use and enforcement, and gang prevention and enforcement, but these types of interventions do not necessarily address the root causes of community violence and have only been found to have short-term impact, if any.^{31 33 54–57} Instead, we apply an assets-based, community-driven framework, anticipating that solutions for community gun violence can originate from both preventing and mitigating impacts of gun violence, as well as building on existing neighbourhood assets. Specifically, we will identify ‘positive deviants’, who are closest to gun violence and can speak firsthand about community assets that may prevent and mitigate effects of gun violence. Using this framework is innovative and may identify novel interventions, which as of yet have not been applied to community gun violence.

The utilisation of participatory modelling to address the conceptual and analytical challenges inherent in identifying and estimating the impact of multiple

community factors on chronic community gun violence is also a novel approach. Few prior interventions to reduce gun violence have been led by community or in full partnership with community, despite literature indicating the importance of community ownership and partnerships between informal (community) and formal (police and government) social control in creating sustainable reductions in gun violence.²⁴ We will use participatory modelling to engage the community and to identify and create informal and formal social control partnerships. Additionally, the system dynamics model that the group of community stakeholders create will be one of the first to address chronic community gun violence. Through its creation, key resilience levers can be identified and bolstered, and multifaceted interventions can be explored in an inexpensive and non-harmful trial in silico before implementation and formal evaluation in the real world. This aspect is particularly useful for community gun violence because of the many severe and inter-related negative health outcomes associated with it. The system dynamics model could also be adapted by other communities interested in designing interventions to reduce exposure to gun violence and its health impacts.

Our proposed study plan has limitations to consider. First, as with any community engaged study, it is possible community priorities may diverge from the study proposed and that the time needed to complete the work will exceed the time allotted. However, gun violence has been a major problem in our community for decades, and we have been engaged with many of these committed partners since 2011, so we expect the issue to remain salient. Second, the social network analysis approach for this model seeks to maximise the quality of network data, which may limit broader generalisability of the social network analysis. Third, while we will rely on our social network data and community member input to identify ‘positive deviants’ for the qualitative interviews, it is plausible that we may miss some important community stakeholders’ perspectives on violence-mitigating community assets. However, we plan to sample until we reach theoretical saturation. Fourth, though we plan to use police data to conduct the spatial analyses, these data are incomplete and will miss shootings that were not reported to the police. Finally, it is possible that the group model building process and will not result in participant openness to challenging their mental models, which would make it challenging to identify novel, multisector, collaborative interventions.^{58 59} However, we will engage the community stakeholders for multiple sessions over time in order to build cohesive relationships across sectors and will use the system dynamics model to increase participant openness to new ways of thinking and challenge the phenomenon of policy resistance.

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