Journal of Aggression, Conflict and Peace Research

Strengthening community-level understanding of and responses to intimate partner violence using geographic information systems (GIS)

Christine Murray Rick Bunch Eleazer D. Hunt

Strengthening community-level understanding of and responses to intimate partner violence using geographic information systems (GIS)

Christine Murray, Rick Bunch and Eleazer D. Hunt

Christine Murray is an Associate Professor at the Department of Counseling and Educational Development, University of North Carolina at Greensboro, Greensboro, North Carolina, USA.
Rick Bunch is a Professor at the Department of Geography, University of North Carolina at Greensboro, Greensboro, North Carolina, USA.
Eleazer D. Hunt is the Manager of Information Services at the Greensboro Police Department, Greensboro, North Carolina, USA.

Abstract

Purpose – *Recently, there has been increased attention to community- and neighborhood-level influences on rates and experiences of intimate partner violence (IPV). The purpose of this paper is to describe the use of geographic information systems (GIS) to geographically analyze these influences in order to enhance community-level understanding of and responses to IPV.*

Design/methodology/approach – *The authors review existing literature supporting the needs for this level of analysis, and then they present eight steps for researchers and practitioners to use when applying GIS to analyze IPV.*

Findings – *This is a conceptual paper.*

Research limitations/implications – *This paper offers researchers and practitioners suggested strategies for using GIS analyses to examine community-level influences on IPV in future research.*

Practical implications – *The practical implications of using GIS analyses are discussed, including ways that the findings of these analyses can be used to enhance community-level resources to prevent and respond to IPV.*

Social implications – *This innovative, interdisciplinary approach offers new insights into understanding and addressing IPV at a community level.*

Originality/value – *To date, there has been minimal research used to apply GIS analyses to the problem of IPV in communities. This paper presents a framework for future researchers and practitioners to apply this methodology to expand on community-level understanding of IPV.*

Keywords *Domestic violence, Intimate partner violence, Geographic information systems, Law enforcement, Community responses, Spatial analyses*

Paper type *Conceptual paper*

Intimate partner violence (IPV) remains a significant public health issue, impacting a large proportion of the population in the USA and around the world. For example, the National Intimate Partner and Sexual Violence Survey by the US Centers for Disease Control and Prevention (Black *et al.*, 2011) revealed that over one-third of women and over one-fourth of men in the USA had experienced some form of sexual or physical violence or stalking within an intimate relationship at some point in their lives. Rates of psychological abuse were even higher, with about one-half of both men and women reporting experiences of this type of violence in their lifetimes. Given these high rates, a need remains for ongoing research and practical advances to improve resources, services, and community-level responses that will aim to prevent future violence, provide support to victims and survivors, and hold offenders accountable.

Received 12 January 2016
Revised 12 April 2016
Accepted 12 April 2016

The authors would like to thank Captain Mike Richey, Lieutenant Jill Gladieux, and Sergeant Jack Steinberg of the Greensboro Police Department for their contributions and collaboration on the work described in this paper.

Historically, most research on predictors of and influences upon IPV has focussed on individual-level variables and interventions (Beyer *et al.*, 2013, 2015; Button, 2008). However, as will be discussed in the literature review, scholars have increasingly argued for the importance of understanding community-level variables and how they impact various forms of violence, including IPV. As attention to community- and neighborhood-level variables has increased, the need for new tools to examine these variables has grown as well. One promising innovation to understanding and addressing how community- and neighborhood-level characteristics influence IPV is found in geographic information systems (GIS). GIS analyses capture, store, retrieve, and analyze geographically referenced data. Research that leverages GIS can enable collaborative environments and promote advances in both research and practice. In general, the term, GIS, describes "a wide and rapidly growing range of applications with the specific characteristic that their information has a geographical or spatial component" (Coy *et al.*, 2011, p. 405). Data used within GIS analyses "must relate to points, lines, or areas within a special referencing system […] displaying data spatially to provide a perspective that could not otherwise be obtained" (Coy *et al.*, 2011, p. 405). Within GIS analyses, locations are geocoded by matching addresses with reference features, such as address points, street address ranges or some geometrically centralized point (Coy *et al.*, 2011). Once locations have be coded in this way, they are able to be compared with characteristics of an area, such as nationally or locally available surveys or other area information (Coy *et al.*, 2011). In light of these possible applications of GIS to examining patterns of IPV within communities, the purpose of this paper is to provide a foundation for future research and practice that leverages GIS for understanding and enhancing interventions related to IPV.

Literature review

Research on community influences on IPV began in the mid-1990s, and interest has grown steadily since then (Beyer *et al.*, 2015). Before addressing some of the major findings from the research to date, it is important to note that there are several common limitations within the current body of research that should be considered when interpreting and generalizing the findings. First, although there is growing attention to this topic, IPV currently has received less research attention with respect to neighborhood variables, as compared to other social issues and other forms of violence. Other issues that researchers have previously examined within a neighborhood context include infant health, substance abuse, mental health symptoms, heart disease, mortality (Caetano *et al.*, 2010), juvenile delinquency (Chauhan *et al.*, 2009), and elder abuse (Dimah and Dimah, 2004). Second, most of the existing research is based in the USA (Beyer *et al.*, 2015). Third, most research involves cross-sectional studies that are not able to be used for determining causation (Beyer *et al.*, 2015). Fourth, another limitation is a lack of inclusion of the lived experiences of people who actually live in neighborhoods with higher risks (O'Campo *et al.*, 2005). Finally, there are key areas in which research is especially limited, including research on rural areas, research grounded in a clear theoretical framework, research examining differences among IPV and other forms of violence, research examining community influences on IPV involving male victims, and research that addresses a range of environmental influences on IPV, including the accessibility of resources (Beyer *et al.*, 2015).

Despite these limitations, findings from examinations of community-level influences on IPV can inform public policy efforts to prevent and respond to future violence (Alaniz *et al.*, 1998). Findings can also be used to inform practice, including how to best allocate resources and prepare for emergency responses to crisis situations related to IPV (Beyer *et al.*, 2013). Intimate relationships and families exist within the context of their surrounding neighborhoods and communities (Benson *et al.*, 2003), so developing a better understanding of the community-level influences is useful for informing decisions related to programs, interventions, other services, and public policies at the community, state, and national levels.

Conceptual frameworks for examining neighborhood influences on IPV

Early research on neighborhood influences on IPV often lacked a theoretical or conceptual framework (Beyer *et al.*, 2015; O'Campo *et al.*, 2005). However, a number of more recent studies have been grounded in social disorganization theory (Benson *et al.*, 2003; Beyer *et al.*, 2013, 2015;

Button, 2008; Van Wyk *et al.*, 2003). This theory holds that disadvantaged neighborhoods have weaker social ties, as compared to more affluent neighborhoods, which contributes to less social control and higher risks of crime (Benson *et al.*, 2003; Beyer *et al.*, 2013; Button, 2008; Van Wyk *et al.*, 2003). Prior to the Benson *et al.* (2003) study, this theory had primarily been applied to other forms of violence, not IPV. However, Benson *et al.* suggested that the theory may apply to IPV because the lower levels of social control may make it less likely that people would intervene or report family violence because of norms that people should not interfere with private family matters. A potential limitation of this theory to IPV is the assumption that a community can monitor IPV, which typically occurs in private, as compared to other forms of crime that occur more publicly (Beyer *et al.*, 2015). In addition, existing research demonstrates that social norms can play a powerful role on whether and how different types of violence are reported to law enforcement (e.g. Felson and Feld, 2009).

Social contagion theory is another framework used to guide research on this topic (Bogat *et al.*, 2005). According to this theory, there is a relationship between violence in the community in general and IPV, such that norms and beliefs about violence are spread through a community as community members develop shared norms about violence (Bogat *et al.*, 2005). Bogat *et al.* tested this theory with a sample of 94 women who were recruited from various community settings. These participants' residential addresses at the time they were interviewed were geocoded to allow for geographic analysis of the data. Overall, Bogat *et al.*'s findings did not support social contagion theory, in that they did not find links between levels of community violence and IPV, nor did they find links between community violence and mental health outcomes. There was, however, a statistically significant relationship between experiencing IPV and mental health symptoms, including depression, anxiety, and PTSD.

Neighborhood influences on IPV

Both social disorganization theory and social contagion theory have shown usefulness for conceptualizing neighborhood and community-level influences on IPV. However, additional work is needed to provide a more comprehensive, applicable theoretical framework for understanding these influences. Moving beyond these frameworks, the existing research demonstrates that a wide range of potential influences should be accounted for in research on this topic. Before investigating specific variables that have been examined, it is important to note that neighborhood variables are most useful to examine through an intersectional lens that also accounts for influences at other levels, including the individual and relationship levels.

The need for an intersectional examination of neighborhood influences on IPV

Existing research demonstrates that neighborhood influences on IPV cannot be considered in isolation from other levels of influence, including individual characteristics, relational dynamics, and intergenerational family patterns. This need underscores the importance of examining neighborhood influences not as the sole causal factor of IPV, but rather as one category of influential variables that interacts with other influences to determine whether and how IPV is experienced within specific community contexts. As an example of research exemplifying this intersectional approach, Caetano *et al.* (2010) examined how people perceived their neighborhoods with respect to social control and social cohesion, and how this impacted experiences of IPV, while also accounting for neighborhood poverty and other socioeconomic variables. This study included a random sample of married or cohabiting couples in the USA. Participants were surveyed as part of a separate wave of interviews. In all, 1,136 couples participated in the second wave of interviews, from which the data were drawn for this study. The sample was racially diverse, with 232 black couples, 387 Hispanic couples, and 406 white couples. Their analyses revealed a significant correlation between neighborhood poverty and IPV, but there was not a significant mediation effect for perceived social control or social cohesion. Caetano *et al.* suggested that the findings may reflect that IPV, as compared to other forms of violence, is influenced more by individual and relationship characteristics than by neighborhood influences.

Other researchers have supported this contention. First, Golden *et al.* (2013) used data from a nationally representative sample of mothers of young children living in urban areas with intimate partners. In this study, neighborhood disadvantage was not significantly related to the women's

experiences of IPV, but rather was related to individual and relationship variables (e.g. financial hardship, economic dependence, and holding traditional gender beliefs). Second, Kiss *et al.* (2012) used survey data from 940 women in Brazil, who were part of a multi-country women's health study by the World Health Organization in order to examine socioeconomic and neighborhood influences on women's risk for IPV. The strongest risk factors for IPV in this study were being in the mid-range of socioeconomic status; having partners who consumed high levels of alcohol, used more controlling behaviors, and had more sexual partners; and personally consuming high levels of alcohol. Neighborhood variables were somewhat influential, although the results also suggested that individual-level and relationship variables were more impactful on IPV risk than neighborhood variables.

Beyer *et al.* (2013) suggested a conceptual framework for consolidating the intersectional approach to understanding how multiple levels of variables may be considered at once. In their model, there are four levels of factors that impact IPV, ranging from the macro- to the micro-level: policy and systems factors; residential and environment factors; family and relationship factors; and individual and personal factors. Within the residential and environmental factors domain, Beyer *et al.* (2013) suggested that there are two unique categories: urban settings and rural settings. They suggested that different neighborhood and community variables may play a more significant role depending on whether a community is urban or rural. For example, urban settings may be more influenced by residential instability, the presence of criminal activity, and physical and social disorder, whereas rural settings may be more influenced by isolation and long distances to services. However, within their framework, these variables also interact with broader social influences, as well as relational and individual characteristics, as they influence the patterns and dynamics of IPV.

Third, Van Wyk *et al.* (2003) suggested that the interactions among neighborhood influences and individual and relationship characteristics offer a more comprehensive approach to understanding IPV. In particular, they suggest that it is nearly impossible to tease apart neighborhood variables from personal characteristics. For example, people with lower incomes would tend to live in neighborhoods with higher rates of poverty. In their study using data from Wave 2 of the National Survey of Families and Households in 1994, as well as 1990 Census data, they found significant relationships among various individual, relationship, and neighborhood variables and IPV, suggesting that a multi-lateral approach to examining these variables is a more useful approach than seeking to focus on only one level at one time. Finally, additional research suggests that perpetrator characteristics may be more influential than neighborhood characteristics for understanding IPV. For example, Harris *et al.* (2011) examined the influence of antisocial traits of perpetrators, other attitudes and values held by perpetrators, relationship dynamics, and neighborhood characteristics on IPV experiences. They found that the strongest effect on frequency of IPV was the perpetrator demonstrating antisocial traits. The other three variables (i.e. other perpetrator attitudes and values, relationship dynamics, and neighborhood characteristics) added small additional influences to the explanation of IPV, but the effect of these variables was minimal. This finding provides an important reminder to researchers to include a focus on perpetrator characteristics that contribute to IPV, rather than just on victim/survivor characteristics or neighborhood characteristics.

Neighborhood- and community-level influences on IPV

Within this broader, intersectional framework for understanding the neighborhood- and community-level influences on IPV, it is useful to examine the range of specific neighborhood variables that have been studied in previous research. The variables that have been examined in past research can be grouped into the following eight categories: alcohol-related variables; criminal activity: general and IPV-specific; demographic composition of neighborhoods; educational variables; neighborhood disadvantage indicators; perceptions of community norms and attitudes; presence of institutions; and residential characteristics.

Alcohol-related variables studied in previous research include the concentration of alcohol outlets (Alaniz *et al.*, 1998), alcohol outlet density (Roman and Reid, 2012), and average alcohol consumption per week and binge drinking among neighborhood residents (Caetano *et al.*, 2010). Criminal activity-related variables the previous researchers have examined include overall rates of criminal activity and murder (Beyer *et al.*, 2013) and situational factors at the time of the IPV incident,

such as location, time, and whether weapons were used (Lee *et al.*, 2013). Neighborhood demographic variables examined in previous research include age (Caetano *et al.*, 2010; Lee *et al.*, 2013), the ethnic minority population (Beyer *et al.*, 2013; Caetano *et al.*, 2010; Lee *et al.*, 2013; Van Wyk *et al.*, 2003), female-headed households (Lee *et al.*, 2013), and percentage of residents who are immigrants (Alaniz *et al.*, 1998; Lee *et al.*, 2013). Educational variables that have been studied previously include education levels among the population and women's literacy rates (Beyer *et al.*, 2015; Caetano *et al.*, 2010; Van Wyk *et al.*, 2003).

Other researchers have examined indicators of neighborhood disadvantage, such as social disorder (Herrero and Gracia, 2005), social disorganization (Button, 2008), per-capita income (Beyer *et al.*, 2015; Caetano *et al.*, 2010), percentage of residents living in poverty (Benson *et al.*, 2003; Beyer *et al.*, 2015; Caetano *et al.*, 2010; Lee *et al.*, 2013; Van Wyk *et al.*, 2003), percentage of residents receiving public assistance (Lee *et al.*, 2013; Van Wyk *et al.*, 2003), and employment rates (Beyer *et al.*, 2015; Caetano *et al.*, 2010; Lee *et al.*, 2013; Van Wyk *et al.*, 2003). Additional research has focussed on neighborhood perceptions of community norms and attitudes. These include collective efficacy (i.e. whether neighbors would intervene in problems in the neighborhood; Button, 2008); community attitudes toward women (Beyer *et al.*, 2015); community norms related to IPV (Beyer *et al.*, 2013, 2015), and perceived frequency of IPV within one's neighborhood (Herrero and Gracia, 2005). The presence of institutions has been examined by other researchers, specifically the presence of churches (Triplett *et al.*, 2013). Finally, researchers also have examined residential characteristics of neighborhoods as they relate to IPV, including the percentage of owner-occupied homes (Lee *et al.*, 2013), population density (Van Wyk *et al.*, 2003), residential instability (Benson *et al.*, 2003; Beyer *et al.*, 2013; Lee *et al.*, 2013), and urbanity versus rurality (Beyer *et al.*, 2013; Bosch and Schumm, 2004; Dimah and Dimah, 2004; Grossman *et al.*, 2005; Peek-Asa *et al.*, 2011).

A comprehensive review of research on the neighborhood variables that have been examined in relation to IPV is beyond the scope of this paper. However, overall, the findings about neighborhood influences on IPV has produced mixed findings (Beyer *et al.*, 2014, 2015; Caetano *et al.*, 2010), which may reflect a failure to consider the interactions among neighborhood variables with influences at other levels. However, of the 36 studies reviewed in one systematic review of research on this topic, 30 demonstrated at least some evidence that neighborhood influences are associated with IPV (Beyer *et al.*, 2015). Of course, there are an extensive number of possible neighborhood-level influences on IPV (Beyer *et al.*, 2015), and the ways in which these factors impact IPV likely vary from community to community. Therefore, any geographic analysis of IPV should consider ways to account for potentially meaningful neighborhood influences on IPV, and the variables identified above can inform decisions about the variables to consider in future work.

The value of using GIS to examine community influences on IPV at the local level

The research discussed in the previous section highlights the importance of examining neighborhood and community-level influences on IPV, as research suggests that these influences impact rates of IPV, as well as how IPV is experienced by victims living within those communities. Although much of the existing research has examined these influences at a broad-based population level (i.e. at a state or national level), the examination of neighborhood influences on IPV also holds value at the local community level. For example, Coy *et al.* (2011) wrote that GIS analyses, in relation to mapping IPV, have the potential to "visually represent women's everyday experience in ways that connect to political and social contexts and through the use of maps powerfully visualize aspects of inequalities" (p. 405). By using GIS to map community patterns of IPV, researchers, practitioners, and policymakers can collaborate to strengthen community efforts to prevent and respond to IPV.

Geographic analysis is especially useful for identifying spatial relationships among feature locations such as barriers to service delivery for victims of IPV. Research by Hetling and Zhang (2010) and Coy *et al.* (2011) illustrates the valuable information that can emerge from this type of research. First, Hetling and Zhang (2010) used GIS to examine whether services for victims of IPV are located in areas where the greatest needs for these services exist. They compared the locations of agencies with police reports of IPV in Connecticut. Their findings demonstrated that there was no relationship between whether a town has a domestic violence service agency and

the rates of IPV, although it was generally not the case that there were any areas in which agencies were either overrepresented or underrepresented. They also examined how poverty rates were associated with IPV, and they found that there were higher rates of both poverty and IPV clustered in urban areas.

Coy *et al.* (2011) used GIS to examine the accessibility of services for victims of IPV and sexual violence. Based in the UK, this two-part study first mapped the location of specialized services for these populations, and then calculated and mapped the distance and direction traveled by women who accessed these services in the process of escaping an abusive relationship. The researchers identified specialized domestic and sexual violence service agencies through various directories and on-line resources that captured this information. Data were collected in 2007 and 2009 for services throughout the UK, although only data collected in 2009 were analyzed for this study. The data included only organizations that had a specified geographic catchment area, so national hotlines were not included. The 825 specialized support services that were included were geocoded to a regional level, although the researchers noted that these services may have served women living outside of these areas. These data were used to produce maps to depict the concentration of services in the UK, including the basic number of services in each region and the population density of women compared to the number of specialized services in each area. The findings were useful for identifying several service gaps, such as that about one-third of all regions had no specialized services for victims of IPV.

In their second study, Coy *et al.* (2011) aimed to move beyond typical geographic methods used in crime analysis (e.g. hot spot analyses), in order to more accurately capture the geographic paths women take when seeking safety from an abusive relationship. The sample included 550 women who accessed shelters during a single year. The researchers obtained the women's locations just prior to coming to the shelters and geocoded these locations. They then calculated, in miles, the distance from the prior location to the shelters from which they sought help. Next, they created maps that demonstrated the migration patterns women took to the shelter locations. The analyses revealed that many women traveled to shelters outside of their local regions. Distances were longer from rural areas and shorter for culture-specific refuges. In the total sample, the average distance women traveled was 35 miles, and about half of the women traveled less than 25 miles from their prior residents, although about one-fifth traveled more than 50 miles and many even traveled over 100 miles. The usefulness of this information was its ability to demonstrate that many women leave their local areas to seek services related to IPV.

Both of these studies (i.e. Hetling and Zhang, 2010; Coy *et al.*, 2011) illustrate the value of GIS for identifying higher-risk and/or under-served populations within communities. The information that can be found through these analyses can be useful for interdisciplinary professionals as they plan community-based interventions to prevent and respond to IPV. For example, law enforcement agencies may use this information to target outreach or plan policing strategies to respond to calls of IPV reports. IPV service agencies can use this information to identify under-served areas and plan strategies for reaching out to these neighborhoods to build stronger linkages between residents and their services. Community-based professionals who are planning outreach and prevention initiatives can use mapping strategies to identify community institutions (e.g. religious institutions or neighborhood associations) that can serve as partners for outreach activities. Additionally, maps of IPV can raise awareness about the prevalence of IPV within communities, provided that they are disseminated in ways that do not increase safety risks for victims or disclose their identities or addresses. Although IPV may be concentrated in certain neighborhoods, it is likely that, in most communities, IPV occurs broadly in communities and at higher rates than many community members are aware Therefore, the benefits of using GIS are multifaceted, and these analyses offer practical information that can be useful for a number of practical purposes. In the next section, we describe eight steps for researchers, practitioners, and policymakers who are interested in using geographic analyses and GIS to understand and enhance responses to IPV in their local communities.

Using GIS to examine IPV at the community level

This section presents eight steps for using geographic analyses to examine IPV within a local community context. These steps are not intended to serve as a singular prescription that will work

in all communities, but rather as a general process that can be adapted to local communities based on local needs, resources, and goals for the analyses. To illustrate each of the steps outlined below, we provide examples from our own work to analyze data from the Police Department of a mid-sized city in the southeastern USA to develop and analyze maps of IPV-related crimes over a five-year time-frame.

Step 1: Determine the goal of your analyses

There are several possible uses and applications of GIS for IPV-related data. At the outset of any analysis process, it is critical to determine the initial goals and related research questions that will guide the data analyses. The initial goals and questions will then guide subsequent decisions about the analysis, including data sources and analysis strategies to be used. Examples of the goals for the analyses may include identifying high-risk neighborhoods that demonstrate higher-than-average rates of IPV; determining whether there are areas in a community that lack access to resources for victims of IPV; examining changing trends in the geographic patterns of IPV over time; and learning basic information about the rates and distribution of IPV within a community.

Illustration of step 1. We began to examine the geographic patterns of IPV within the designated city through a collaborative partnership between the researchers' university and the city Police Department. Members of our research group were interested in both the research and practical implications of these geographic patterns, with an overall goal of examining the geographic landscape of IPV-related crimes in the city to learn about environmental influences on these types of crimes. This work was in line with the Police Department's use of predictive policing to address other types of crime, although previously this policing strategy had been used only to address other types of crime than IPV, such as property and drug crimes. In light of these goals, one main research question guided our analyses:

RQ1. What are the spatial characteristics of IPV in the city?

We discussed the practical implications of this question early in the planning process to ensure that the analyses would be relevant to the needs of the community.

Step 2: Form a collaborative partnership in which each partner's unique expertise and backgrounds are valued

Because of the interdisciplinary nature of this topic, geographic analyses of IPV using GIS should identify professionals with the expertise needed to carry out the project in a way that is both methodologically rigorous and sensitive to the unique dynamics of abusive relationships. Researcher-practitioner collaborations related to IPV are critical to advancing both research and practice, although these collaborations can give rise to both challenges and opportunities (Murray *et al.*, 2010). According to past research, some of the elements that are essential for these collaborations to work include that the expertise of each partner will be valued and respected, strong communication will remain an ongoing focus, and the unique needs and work contexts of each partner will be addressed (Murray *et al.*, 2010).

Although GIS software programs are available to perform geographic analyses (see below for a discussion of some of the available programs), it is useful to have one or more collaborators with expertise in statistical analyses and/or analyses using GIS. Some potential ways to connect with professionals with expertise in GIS include through law enforcement crime analysis units or Geography departments at local colleges or universities. Whether the data come from a law enforcement agency or some other organization, it is essential to include a representative of the organization(s) that provided the data to ensure that the meaning of the data is understood correctly. In addition to experts on statistical analyses, GIS, and organizational data, we recommend that at least one collaborator have an in-depth understanding of the dynamics of IPV. This expertise is essential for ensuring that the analyses are carried out without creating safety risks to victims in the community, as well as to ensure that the findings will be interpreted in light of the unique dynamics of IPV. This latter point is discussed later in the discussion of Step 8, which addresses the interpretation of the findings of the analyses.

Illustration of step 2. From the outset, our research team included a university professor with expertise in GIS, a university professor with expertise in the dynamics of IPV, and a crime analyst

with extensive GIS and statistical analysis knowledge. Additional collaborators provided critical support throughout the project, including senior-level administrators within the Police Department's unit that responds to IPV crimes and administrators working in the local domestic violence agency, which offers shelter, crisis intervention, and advocacy to victims of IPV.

Step 3: Define "neighborhood" and/or "community"

There are a variety of ways that neighborhoods can be defined, and more standardized definitions of neighborhoods will be a useful direction for future research (Beyer *et al.*, 2015). A complicating factor about neighborhoods is that, even though the actual people living in a neighborhood may change, over time there are likely consistent patterns in the types of people who select or are able to live in certain neighborhoods (Benson *et al.*, 2003). Another complicating factor is that people's social networks are not confined to their neighborhoods (Benson *et al.*, 2003), and therefore the community-level influences on their experiences of violence may extend to other social network levels, such as employment, religious, and other social contexts. Researchers and practitioners using GIS to examine IPV can address these complicating factors by creating a clear, objective understanding of how neighborhoods will be defined from the outset of their work, as well as by considering the definition they use as they interpret the findings of their analyses.

Often, the ways that neighborhoods are defined for GIS analyses differ from the ways neighborhoods are understood by people actually living in those neighborhoods. Within the general population, people may define their "neighborhood" in a variety of ways – such as by the street on which they live, the name of a housing development, or a part of town. However, GIS analyses require a standardized definition of neighborhoods, and these definitions may not align with community perceptions of neighborhood boundaries. Factors that influence the level at which a neighborhood is defined include the nature of the data available, whether data from local or national data sources (e.g. the US Census) will be used, and the purpose of the analyses.

There are a number of levels at which GIS analyses may classify neighborhoods. One broad way to define neighborhoods is to classify them as rural or urban using Rural-Urban Commuting Area Codes (RUCA; Rural Health Research Center, 2015). According to the Rural Health Research Center, RUCAS are a "Census tract-based classification scheme […] to characterize all of the nation's Census tracts regarding their rural and urban status and relationships" (paragraph 1). This classification system has been applied in research on IPV (Beyer *et al.*, 2013), although it is a broad system and therefore has limited usefulness for examining more specific community-level variables.

Other ways to classify neighborhoods include self-report methods, city-defined neighborhoods, and Zone Improvement Plan (ZIP) codes (Beyer *et al.*, 2015). ZIP codes are perhaps the most familiar geographic unit used by people who are not GIS experts, and they have been used in prior research on neighborhood influences on IPV (Coy *et al.*, 2011; Peek-Asa *et al.*, 2011). In the context of conducting geographic analyses in a GIS, the definition of "zip code" and its use as a data collection unit is ambiguous and often overlooked. ZIP Codes represent a collection of mail carrier routes made up of individual addresses. These data can be viewed as a list of addresses that help make mail delivery more efficient. In many cases, ZIP codes are not aligned with geographic distinctions made in data collected in Census data and geocoded locations. Researchers conducting geographic analysis at the ZIP code level should be aware of this issue, especially if they are using Census data. In general, ZIP codes are limited in their utility for conducting detailed analyses in a GIS because they represent large swaths of geographic areas. By default, any geographic analyses that occurs at the ZIP code level automatically assumes homogeneity of the underlying population when, in reality, the characteristics of the people within each zone may be quite different.

Geographic analyses using GIS can provide richer information when incorporating data from the US Census, as Census data can be used to identify a variety of social and demographic characteristics of neighborhoods. Census data can be examined at different levels, and the main levels used for large to medium geographic scale studies are tracts, block groups, and census blocks (US Census Bureau, 2010). The largest of these levels are census tracts. A number of researchers examining neighborhood influences on IPV have focussed on the census tract level

(Benson *et al.*, 2003; Beyer *et al.*, 2013, 2014; Caetano *et al.*, 2010; Lee *et al.*, 2013; Van Wyk *et al.*, 2003). However, a critique against using census tracts is that they are too large of an area and do not capture the heterogeneity of the neighborhoods (Bogat *et al.*, 2005). Therefore, GIS analyses using Census tract data may lack the specificity needed to provide meaningful information with useful implications for research or practice.

On the other hand, the smallest level of census data, census blocks may be too small to provide meaningful information, due to Census Bureau restrictions and privacy policies. A census block within an urban area may closely approximate one city block (US Census Bureau, 2011). Given this level of specificity, rates of IPV within specific census blocks may be too low to aggregate and identify meaningful patterns of IPV, with the exception of specific neighborhoods that have exceptionally high concentrations of IPV. Furthermore, protecting the privacy and safety of victims is essential for conducting research on IPV, and there is a risk at this fine level of analysis that victims may be identified, given the small size of census blocks.

Thus, the middle level of analysis of Census data – block groups – is the most promising approach for GIS analyses to examine IPV. To date, however, this level of analysis has received minimal attention (Alaniz *et al.*, 1998; Beyer *et al.*, 2015; Button, 2008; Roman and Reid, 2012; Triplett *et al.*, 2013). Block groups are "equivalent to about four city blocks" and are "a more realistic estimate of naturally occurring neighborhoods" (Bogat *et al.*, 2005, p. 125). Roman and Reid (2012) suggested that using a level of analysis larger than block groups runs the risk of overlooking important variables that are only evident at smaller levels. Likewise, Triplett *et al.* (2013) suggests that block group data more accurately capture neighborhood characteristics than larger area groupings. Triplett *et al.*'s reported that, in their study, Census block groups were relatively consistent with how the community defined the confines of neighborhoods. Thus, we recommend that, whenever possible, GIS analyses of IPV use Census block group-level data.

Illustration of step 3. In our analyses, Census block group-level data were used for two primary reasons. First, this level of data allowed us to incorporate Census data to understand the demographic characteristics of neighborhoods identified as having higher- or lower-than average rates of IPV. Second, from a practical standpoint, this level of analysis permitted us to create a series of maps to show the landscape of IPV in the community, and these maps helped to identify specific neighborhoods that were "hot spots" for IPV in the city. Furthermore, by coding specific addresses of IPV incidents to a block group, the maps we created did not disclose any addresses of victims that would compromise their safety and privacy.

Step 4: Identify and prepare the data to be analyzed

Researchers and practitioners have a range of options to use in GIS analyses of IPV. In general, the analyses may integrate data from both local and state and/or national data in order to provide a rich analysis of the data. Again, the goals of the analyses that were identified in Step 1 should guide the selection of data sources for the analyses. This section describes three main sources of data: self-report data, agency records, and national databases.

Self-reported data may be used to solicit addresses from research participants (Bogat *et al.*, 2005). Community surveys can gather data through the general population (e.g. Button, 2008; Caetano *et al.*, 2010) or clinic-based settings (e.g. Peek-Asa *et al.*, 2011). Previous research on IPV suggests that different types of IPV (i.e. intimate terrorism/battering and situational couple violence) are more or less likely to be detected in research based on the methodology used (e.g. clinical settings vs general community surveys) (Johnson, 2006). Therefore, survey data can provide a useful source of data for understanding rates of IPV in a community, particularly for identifying IPV that may not be reported to law enforcement or social service agencies. However, certainly social desirability biases could also influence researchers' ability to detect IPV through survey research. Therefore, when considering rates of IPV within communities, it is useful to draw upon multiple data sources in order to maximize the strengths and minimize the limitations of any one data source. Additional information about the complexity of reporting IPV is discussed below in the context of discussing the interpretation of research findings.

Agency records also can provide useful information for GIS analyses of IPV. The most commonly used source of agency data in this area to date has been the use of law enforcement

agency records. For example, past researchers have worked with local and state police departments, such as to examine violent crimes (Alaniz *et al.*, 1998), reports of IPV incidents and assaults (Hetling and Zhang, 2010; Lee *et al.*, 2013), and arrest data (Miles-Doan, 1998). In addition to law enforcement agencies, other community-based agencies that may have relevant data for GIS analyses of IPV within a community include domestic violence agencies, crisis hotlines, Child Protective Services units, or hospital emergency departments. Each of these agencies has unique privacy and confidentiality restrictions on the types of data they can provide. Therefore, any plans regarding data from these sources much follow all relevant laws and confidentiality requirements, such as by the agency providing a de-identified database that does not disclose any personally identifying information. In addition to local agencies, state-level agency data sources can be used in GIS analyses of IPV, such as a Statewide Violent Death Reporting System or state domestic violence coalition lists of homicides (Beyer *et al.*, 2013, 2014), as well as state coalition lists of local agencies (Hetling and Zhang, 2010).

National databases also can supplement the above sources of data in order to provide a richer analysis of the data. As discussed above, US Census data are useful for examining community-level variables (Benson *et al.*, 2003; Beyer *et al.*, 2013; Button, 2008; Caetano *et al.*, 2010; DeMaris *et al.*, 2003; Golden *et al.*, 2013; Hetling and Zhang, 2010; Kiss *et al.*, 2012; Triplett *et al.*, 2013), such as neighborhood rates of poverty, divorce, immigrant populations, and the proportion of adults in the labor force in professional/managerial occupations (Alaniz *et al.*, 1998). Researchers also have drawn upon other national databases, such as the National Survey of Families and Households (DeMaris *et al.*, 2003; Van Wyk *et al.*, 2003), the Fragile Families and Child Wellbeing Study (Golden *et al.*, 2013), and the Spanish Demands of Security and Victimization Survey (Herrero and Gracia, 2005). Also, researchers interested in the links between IPV and substance use have used data from state ABC Boards, such as to identify alcohol outlets in various cities (Alaniz *et al.*, 1998).

Additional steps likely will be needed in order to prepare the available for geographic analyses. Data with geographic points of IPV incidents (e.g. police reports, 911 calls, and/or agency records) may need to be geocoded in order to be used for further GIS analyses (Alaniz *et al.*, 1998; Beyer *et al.*, 2013, 2014). Geocoding involves the assignment of geographic coordinates to postal addresses, place names, or descriptions of locations (Shah *et al.*, 2014). It is very similar to putting pins on a paper map. The geocoding process involves a geocoder that handles two sets of data: the address data that are to be located on the map, and the georeferenced database used to plot the address at its known location. The georeferenced database can be constructed using point, lines, or polygons and attributes with known addresses. For example, residential housing may be represented by points that mark the roof top of each home. If the desired address is matched, then a point will be placed exactly on the roof top. Street centerlines with address ranges also can be used to interpolate individual addresses along a road, such as by coding a specific address to the middle of a line segment representing the street on which it is located. Similarly, polygons can be used to geocode. If the desired address is geocoded by ZIP code, then the location is placed within the matched polygon, usually the centroid. The geocoder iterates the process for all addresses and produces a score to indicate the strength of the match.

Illustration of step 4. The primary source of data used in our research was a database of domestic violence reports to the city Police Department. The database was extensive, and it included a vast amount of information about each report, including the incident address, the date and time of the incident, criminal charges that were filed, and whether a weapon was used. To supplement this data, additional local data used included a record of 911 calls during the same time-frame. These local data were geocoded in order to permit the GIS analyses. In addition to the local data, US Census data at the block group level were used to further explore the social and demographic characteristics of the neighborhoods identified as “hot spots” for IPV.

Step 5: Plan and carry out the GIS analysis

Data for analysis in GIS are structured and stored in a digital format through two common data models. The first type is called the vector data model. The vector data model is used to store data that represent discrete features using points, lines, and polygons, such as cities, rivers, and county borders. The second type is called the raster data model. The raster data model is used to

store data for phenomena that occur continuously such as elevation or temperature. Together, these two data models provide the foundation for a geospatial database that can be examined through geographic analysis.

The analysis of IPV using GIS involves several steps to address a series of questions. The first questions to consider are where do the incidents occur, and where are the highest incidence rates? Answering these questions involves two steps: obtaining the locational data, and performing an analysis to determine the relative frequency. Following the geocoding of the data, the Optimal Hotspot Analysis (OPA) method is the preferred approach for mapping IPV incidents, because it normalizes the size of the units of analysis based on the number of reported crimes, and therefore it produces a statistically valid representation of hot spots in the targeted geographic area. Once the hot spots have been identified, another question arises: what are the characteristics of the households that fall within a hot spot or a cold spot? These questions can be answered by obtaining attributes of Census block groups, overlaying them, and performing queries that extracts Census data at the hot/cold spot locations.

There are numerous types of GIS software. Some are freely available, while others require a licensing fee. GIS software is often placed into categories based upon their purpose. These categories include desktop, web mapping, server, virtual globes, developer, and hand-held devices. Significant and well-established commercial GIS software vendors include ESRI Inc., Autodesk, Bentley, and Intergraph Inc. The capability of the GIS software produced by each vendor varies in terms of functionality and architecture, although technology advances have minimized these differences. Open-source GIS software is also readily available, including gvSIG for desktop mapping and GIS, GeoDa for spatial analysis and visualization, and PostGIS for storing data. Most open-source GIS software programs offer base functionality and some analytical capabilities, although additional enhancements can be obtained from software developers from around the world, who share their geographic information and software via the Open Geospatial Consortium, which is a software development organization that encourages and promotes standards for GIS development and data sharing.

Illustration of step 5. We obtained the geographic coordinates for all reported domestic violence occurrences (i.e. all reports that were noted by the Police Department to have involved domestic incidents) in the city from the Police Department. The data were geocoded using a composite address geocoder, which was built to include both point (actual addresses as points), lines (street address ranges), and polygons as the underlying matching geometry. The preferred location, in this case, was the address point, but if an unsatisfactory match occurred, the geocoder moved to consider the other geometry in order of preference (points first, lines second, and polygons last). Once domestic violence incidents were plotted, an OPA was implemented to identify the regions where the highest incidence of IPV occurred. Once hot spots were identified, additional analyses were conducted using Census data to examine the social and demographic characteristics of the block groups identified as hot spots for IPV.

Step 6: Explore additional questions that emerge from the initial analyses

As the GIS analysis approach is likely to be new to many researchers and practitioners in the IPV field, the initial findings of the analyses will likely lead to further questions. There are many possible applications of a geographic understanding of IPV, such as for practice, policy, research, and prevention. In addition, a geographic analysis of IPV is a dynamic process examining an ever-changing phenomenon. Maps are really only a snapshot of a single point-in-time and can quickly become outdated, since services and rates of IPV may change over time (Coy *et al.*, 2011). In particular, the dissolution of a relationship due to IPV may result in one or both partners relocating (Fabricius and Braver, 2006). Therefore, an initial GIS analysis represents a single point-in-time description of IPV within a particular community, and therefore efforts should be made to maintain an ongoing analyses process that accounts for changes over time and new questions that emerge through both research and practice initiatives.

Illustration of step 6. Once we created the initial versions of the maps from the Police Department records to depict the spatial characteristics of IPV in the city, we held a meeting with our entire research team, as well as representatives from the local domestic violence service agency.

At this meeting, we discussed the initial maps and, as a group, brainstormed additional questions that emerged from those maps. Several additional questions emerged, and the main focus of the subsequent questions was on gaining a more nuanced understanding of IPV in the city. Thus, additional maps were created that examined different time-frames (e.g. one year vs five years) and examined different types of crimes (e.g. simple assault and aggravated assault).

Step 7. Interpret the findings with consideration of the dynamics of abusive relationships

IPV involves complex relational dynamics and contextual influences, so it is important to address this complexity when interpreting maps resulting from GIS analyses (Coy *et al.*, 2011). Therefore, it is important to draw upon the expertise of researchers and practitioners who address IPV in the interpretation of a GIS analysis of IPV. The issue of reporting warrants special consideration in the interpretation of geographic analyses of IPV. Because a GIS analysis will include only IPV that has been reported in some way – whether that is in a community survey, through a police report, or by a victim seeking help from an agency – it is essential to ensure consideration of the challenges associated with reporting IPV. The most important consideration is to remember that reported IPV likely does not fully reflect actual IPV occurring in communities. In particular, there are several possible reasons that IPV may be more likely to be reported in more socioeconomically disadvantaged communities. First, people who live in lower-income neighborhoods may be more inclined toward violence (Benson *et al.*, 2003). Second, the economic stress associated with poverty may contribute to greater tension in couple relationships, and this stress could serve as a trigger for violence (Benson *et al.*, 2003).

Third, it is possible that rates of IPV are the same across neighborhoods, regardless of socioeconomic status, but that IPV is reported more frequently within lower-income neighborhoods (Benson *et al.*, 2003). Higher reporting may result from a number of factors (Benson *et al.*, 2003). First, the closer proximity of neighbors to one another may increase the likelihood that others will hear the violence. For example, a neighbor is more likely to hear IPV in an apartment with thin walls, compared with a neighborhood in which homes are made of brick and set apart from one another. Second, people in lower-income areas may have a higher presence of police for other reasons (e.g. other crimes) and therefore may be more likely to call law enforcement and other agencies for help. Third, people in higher-income communities may perceive more potential losses for reporting IPV, including public embarrassment and economic risks, such as if they believe that calling law enforcement will lead to lost employment.

Considering the dynamics of reporting abuse in the interpretation of GIS analyses of IPV is especially important when using the findings for community education and prevention. For example, a map of IPV-related reports to local law enforcement agencies that shows that IPV is most prevalent in lower-income neighborhoods, without providing contextual information about reporting and IPV, could inadvertently reinforce stereotypes that IPV occurs only in certain groups. This unintended message could serve to further marginalize victims of IPV who live in other communities, such as by making them less likely to seek help or recognize abuse in their relationships because they believe IPV does not occur in their community. Thus, we recommend that the results of GIS analyses of IPV be interpreted with extreme caution and sensitivity to the dynamics of IPV, as well as to the unique challenges associated with IPV reporting.

Illustration of step 7. Because our work relied primarily upon records from a Police Department, we discussed the complexities of reporting IPV to law enforcement from the outset of our work. Although the resulting maps did show higher concentrations of IPV in more economically disadvantaged sections of the city, the maps also revealed that there were virtually no sections of the city that were free of IPV. Furthermore, although some of the IPV hot spots were identified in more socioeconomically disadvantaged areas, some other hot spots did not fit this pattern. As such, this provided additional opportunities for further exploring the data in order to understand the neighborhood characteristics that were related most closely to IPV reports.

Step 8. Determine how the findings of the analyses will be used and disseminated

The findings from a GIS analysis of IPV have many potentially useful implications for research, practice, and public policy. As such, an important final step of the analysis is to determine how

and to whom the findings will be disseminated. As part of planning the dissemination of the findings, safety implications must be addressed. For example, in general, it would not be safe to publicly release a map that identifies the addresses of the residents of victims of IPV. This is a violation of their privacy, and it also potentially alerts perpetrators to the locations of their victims. Likewise, the locations of shelters and other similar organizations with undisclosed addresses should never be released, as this can place victims' lives at risk. Disseminating maps that use a higher level of identification than addresses (e.g. census block groups or zip codes) is one possible approach. Other researchers have removed identifying information in their analyses as a protection for victims' confidentiality (e.g. Bogat *et al.*, 2005).

There are several possible dissemination strategies for the results of a GIS analysis of IPV. Results may be disseminated internally, such as for planning purposes within a local agency. In addition, results may be disseminated at a community level, such as through the media or in outreach programs. For example, a local training for teachers and counselors in local schools may include a map to depict rates of IPV within the local community. Also, the results may hold value for broader dissemination, such as through scholarly peer-reviewed journal articles, professional conference presentations, and via social media (e.g. blogging). Overall, dissemination plans should be aligned with the initial goals of the analyses and designed to reach the populations that would most benefit from the information resulting from the analyses.

Illustration of step 8. Our team's dissemination strategy is focussed primarily upon internal dissemination and scholarly research dissemination. Internally, the maps and results of the analyses were disseminated to key personnel in the organizations represented by the members of the research team. This information is intended to be used to enhance local law enforcement and social service delivery to strengthen the community's response to IPV. In addition, the results of our analyses will be reported in scholarly, peer-reviewed articles.

Conclusion

GIS analyses hold promise for strengthening communities' understanding of and responses to IPV. A geographic analysis of IPV provides a process for examining both the spatial and demographic characteristics of people and communities who experience IPV. Two theoretical frameworks – social disorganization theory and social contagion theory – offer frameworks for conceptualizing these analyses and interpreting the results, and there is extensive research that demonstrates the value of considering neighborhood influences on IPV. This paper outlined an eight-step process through which researchers and practitioners can collaborate with GIS experts to examine geographic influences on IPV in local communities. A geographic analysis lens for understanding IPV offers opportunities for strengthening community response systems by using geographic information to help plan and implement community-based strategies to better understand and plan preventive and responsive interventions that address IPV.

References

Alaniz, M.L., Cartmill, R.S. and Parker, R.N. (1998), "Immigrants and violence: the importance of neighborhood context", *Hispanic Journal of Behavioral Sciences*, Vol. 20 No. 2, pp. 155-74.

Benson, M.L., Fox, G.L., DeMaris, A. and Van Wyk, J. (2003), "Neighborhood disadvantage, individual economic distress, and violence against women in intimate relationships", *Journal of Quantitative Criminology*, Vol. 19 No. 3, pp. 207-35.

Beyer, K., Wallis, A.B. and Hamberger, L.K. (2015), "Neighborhood environment and intimate partner violence: a systematic review", *Trauma, Violence & Abuse*, Vol. 16 No. 1, pp. 16-47. doi: 10.1177/1524838013515758.

Beyer, K.M.M., Layde, P.M., Hamberger, L.K. and Laud, P.W. (2013), "Characteristics of the residential neighborhood environment differentiate intimate partner femicide in urban versus rural settings", *The Journal of Rural Health*, Vol. 29 No. 3, pp. 281-93.

Beyer, K.M.M., Layde, P.M., Hamberger, L.K. and Laud, P.W. (2014), "Does neighborhood environment differentiate intimate partner femicides from other femicides?", *Violence Against Women*, Vol. 21 No. 1, pp. 49-64. doi: 10.1177/1077801214564075.

Black, M.C., Basile, K.C., Breiding, M.J., Smith, S.G., Walters, M.L., Chen, J. and Stevens, M.R. (2011), *The National Intimate Partner and Sexual Violence Survey (NISVS): 2010 Summary Report*, National Center for Injury Prevention and Control, Centers for Disease Control and Prevention, Atlanta, GA, available at: www.cdc.gov/violenceprevention/pdf/nisvs_executive_summary-a.pdf (accessed June 24, 2015).

Bogat, G.A., Leahy, K., von Eye, A., Maxwell, C., Levendosky, A.A. and Davidson, W.S. (2005), "The influence of community violence on the functioning of women experiencing domestic violence", *American Journal of Community Psychology*, Vol. 36 Nos 1-2, pp. 123-32. doi: 10.1007/s10464-005-6237-2.

Bosch, K. and Schumm, W.R. (2004), "Accessibility to resources: helping rural women in abusive partner relationships become free from abuse", *Journal of Sex & Marital Therapy*, Vol. 30 No. 5, pp. 357-70. doi: 10.1080/00926230490465118.

Button, D.M. (2008), "Social disadvantage and family violence: neighborhood effects on attitudes about intimate partner violence and corporal punishment", *American Journal of Criminal Justice*, Vol. 33 No. 1, pp. 130-47.

Caetano, R., Ramisetty-Mikler, S. and Harris, T.R. (2010), "Neighborhood characteristics as predictors of male to female and female to male partner violence", *Journal of Interpersonal Violence*, Vol. 25 No. 11, pp. 1986-2009. doi: 10.1177/0886260509354497.

Chauhan, P., Reppucci, N.D. and Turkheimer, E.N. (2009), "Racial differences in the associations of neighborhood disadvantage, exposure to violence, and criminal recidivism among female juvenile offenders", *Behavioral Sciences and the Law*, Vol. 27 No. 4, pp. 531-52. doi: 10.1002/bsl.868.

Coy, M., Kelly, L., Foord, J. and Bowstead, J. (2011), "Roads to nowhere? Mapping violence against women services", *Violence Against Women*, Vol. 17 No. 3, pp. 404-25. doi: 10.1177/1077801211398637.

DeMaris, A., Benson, M.L., Fox, G.L., Hill, T. and Van Wyk, J. (2003), "Distal and proximal factors in domestic violence: a test of an integrated model", *Journal of Marriage and Family*, Vol. 65 No. 3, pp. 652-67.

Dimah, K.P. and Dimah, A. (2004), "Elder abuse and neglect among rural and urban women", *Journal of Elder Abuse & Neglect*, Vol. 15 No. 1, pp. 75-93. doi: 10.1300/J084v15n01_06.

Fabricius, W.V. and Braver, S.L. (2006), "Relocation, parent conflict, and domestic violence: independent risk factors for children of divorce", *Journal of Child Custody*, Vol. 3 Nos 3-4, pp. 7-27.

Felson, R.B. and Feld, S.L. (2009), "When a man hits a woman: moral evaluations and reporting violence to the police", *Aggressive Behavior*, Vol. 35, pp. 477-88. doi: 10.1002/ab.20323.

Golden, S.D., Perreria, K.M. and Durrance, C.P. (2013), "Troubled times, troubled relationships: how economic resources, gender beliefs, and neighborhood disadvantage influence intimate partner violence", *Journal of Interpersonal Violence*, Vol. 28 No. 10, pp. 2134-55. doi: 10.1177/0886260512471083.

Grossman, S.F., Hinkley, S., Kawalski, A. and Margrave, C. (2005), "Rural versus urban victims of violence: the interplay of race and region", *Journal of Family Violence*, Vol. 20 No. 2, pp. 71-81. doi: 10.1007/s10896-005-3170-y.

Harris, G.T., Hilton, N.Z. and Rice, M.E. (2011), "Intimate partner violence by male perpetrators. Do attitude, relationship, and neighborhood variables add to antisociality?", *Criminal Justice and Behavior*, Vol. 38 No. 4, pp. 309-31. doi: 10.1177/0093854810397449.

Herrero, J. and Gracia, E. (2005), "Perceived frequency of domestic violence against women and neighborhood social disorder", *Psychological Reports*, Vol. 97 No. 3, pp. 712-6.

Hetling, A. and Zhang, H. (2010), "Domestic violence, poverty, and social services: does location matter?", *Social Science Quarterly*, Vol. 91 No. 5, pp. 1144-63. doi: 10.1111/j.1540-6237.2010.00725.x.

Johnson, M.P. (2006), "Conflict and control: gender symmetry and asymmetry in domestic violence", *Violence Against Women*, Vol. 12 No. 11, pp. 1003-18. doi: 10.1177/1077801206293328.

Kiss, L., Schraiber, L.B., Heise, L., Zimmerman, C., Gouveia, N. and Watts, C. (2012), "Gender-based violence and socioeconomic inequalities: does living in more deprived neighborhoods increase women's risk of intimate partner violence?", *Social Science & Medicine*, Vol. 74 No. 4, pp. 1172-9.

Lee, J., Zhang, Y. and Hoover, L.T. (2013), "Profiling weapon use in domestic violence: multilevel analysis of situational and neighborhood factors", *Victims and Offenders*, Vol. 8 No. 2, pp. 164-84. doi: 10.1080/15564886.2012.749123.

Miles-Doan, R. (1998), "Violence between spouses and intimates: does neighborhood context matter?", *Social Forces*, Vol. 77 No. 2, pp. 623-45. doi: 10.1093/sf/77.2.623.

Murray, C.E., Smith, P.H. and Avent, J.R. (2010), "Solutions to the research-practice gap in domestic violence: a modified Delphi study with domestic violence coalition leaders", *Journal of Aggression, Maltreatment, & Trauma*, Vol. 19 No. 4, pp. 424-99. doi: 10.1080/10926771003781354.

O'Campo, P., Burke, J., Peak, G.L., McDonnell and Gielen, A.C. (2005), "Uncovering neighbourhood influences in intimate partner violence using concept mapping", *Journal of Epidemiology and Community Health*, Vol. 59 No. 7, pp. 603-8. doi: 10.1136/jech.2004.027227.

Peek-Asa, C., Wallis, A., Harland, K., Beyer, K., Dickley, P. and Saftlas, A. (2011), "Rural disparity in domestic violence prevalence and access to resources", *Journal of Women's Health*, Vol. 20 No. 11, pp. 1743-49. doi: 10.1089/jwh.2011.2891.

Roman, C.G. and Reid, S.E. (2012), "Assessing the relationship between alcohol outlets and domestic violence: routine activities and the neighborhood environment", *Violence and Victims*, Vol. 27 No. 5, pp. 811-28.

Rural Health Research Center (2015), "Rural-urban commuting area codes (RUCAs)", available at: http://depts.washington.edu/uwruca/ (accessed August 11, 2015).

Shah, T.I., Bell, S. and Wilson, K. (2014), "Geocoding for public health research: empirical comparison of two geocoding services applied to Canadian cities", *Canadian Geographer*, Vol. 58 No. 4, pp. 400-17. doi: 10.1111/cag.12091.

Triplett, R.A., White, G. and Gainey, R. (2013), "Churches as neighborhood organizations and their relationship to street and domestic violent crime: the role of denomination, stability, and heterogeneity", *Deviant Behavior*, Vol. 34 No. 10, pp. 803-23. doi: 10.1080/01639625.2013.781440.

US Census Bureau (2010), "Standard hierarchy of census geographic entities", US Census Bureau, available at: www2.census.gov/geo/pdfs/reference/geodiagram.pdf (accessed August 11, 2015).

US Census Bureau (2011), "What are census blocks?", Random Samplings, Official blog, US Census Bureau, available at: http://blogs.census.gov/2011/07/20/what-are-census-blocks/ (accessed August 11, 2015).

Van Wyk, J.A., Benson, M.L., Fox, G.L. and DeMaris, A. (2003), "Detangling individual-, partner-, and community-level correlates of partner violence", *Crime & Delinquency*, Vol. 49 No. 3, pp. 412-38. doi: 10.1177/0011128703253763.

Further reading

Paquin, G.W. (1994), "A statewide survey of reactions to neighbors' domestic violence", *Journal of Interpersonal Violence*, Vol. 9 No. 4, pp. 493-502. doi: 10.1177/088626094009004004.

Corresponding author

Christine Murray can be contacted at: cemurray@uncg.edu