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Understanding intimate partner violence, HIV, and community based resources through a spatial lens among women in Atlanta, GA

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By

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Bachelor of Arts in Global Studies
University of Illinois at Urbana Champaign
2013

Thesis Committee Chair: Ameeta Kalokhe, MD, MSc.

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Abstract

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Author: Neetu Hariharan, MPH

Background: Current research suggests that women who experience intimate partner violence (IPV) are at higher risk of HIV infection. However, there have been limited investigations into the spatial relationship of both IPV severity and HIV prevalence. This study sought to evaluate the utility of spatial tools in exploring the geographic distribution and clustering of IPV and HIV. Additionally, we investigated the allocation of HIV resources to characterize the void of integrative HIV and IPV resources.

Methods*:* Past 12-month and lifetime IPV data obtained from a conveniently sampled cross-sectional study conducted from March through November 2014 of 85 HIV-negative high-risk women residing in metropolitan core Atlanta. AIDSVu provided Atlanta-based HIV data. Information regarding provision of mental health and violence screening was collected from HIV testing and counseling centers. Descriptive and various spatial statistics were performed using STATA 13.0, ArcGIS 10.2.2, Point Pattern Analysis (PPA) tool, and SaTScan 9.4.

Results: High HIV/AIDS prevalence areas were identified in two counties. Marginal IPV severity global clustering trends were found. Localized IPV severity was clustered in the area with high HIV prevalence (2 hot spots; *z-score = 3.17* and $\alpha=0.05$). IPV participants in high HIV prevalence areas were located outside the 1-mile buffer around IPV/mental health integrated resources (n= 38, outside; n=12, inside). However, all 9 of the integrative resources were located in high HIV prevalence areas with clusters of high IPV severity.

Conclusions: Our results suggest that geospatial mapping can be useful to identify regions of high IPV severity and high HIV overlap and to classify geographic gaps in allocation of HIV prevention and IPV community support services. Overall, this study serves as a platform to continue the exploration of spatial tools to address nontraditional socio-behavioral risk issues in research, and contribute to policy and resource discussions.

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I also want to extend my gratitude for the participants and other study staff (Nicole Booker, Naomi David, and Oge Etudo) who contributed to 'The IPV and Biological HIV Risk Study". It has been an amazing opportunity to wear purple coats, listen to all of our participants' stories, and gain invaluable experience with these ladies. Moreover, the PRISM health group who provides publicly available HIV/AIDS data through their project called AIDSVu, and continues to explore ways of reducing transmission in minority populations.

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Chapter 1: Introduction

The third United Nations (UN) Millennium Development Goal (MDG) for 2015 is to promote gender equality and empower women [1]. This includes, reducing violence against women in all forms, such as intimate partner violence (IPV). According to a report consolidated by the World Health Organization (WHO), about 30% of women worldwide have experienced some kind of physical or emotional violence over a lifetime from their intimate partner [2]. Women who experience IPV compared to those who do not, have significantly more health consequences [3]. The Centers for Disease Control (CDC) report that stress, post-traumatic stress disorder (PTSD), anxiety, and depression are among the psychological effects that can occur as a result of experiencing IPV [4]. Survivors of violence are also at a higher risk for sexually transmitted infections (STIs) and HIV due to an increased risk of engaging in high risk behaviors (i.e. unprotected sexual intercourse and substance abuse) [3, 4]. In 2001, the UN General Assembly adopted a commitment to continuing to resolve the HIV/AIDS epidemic [5]. They recognized that the relationship between IPV and HIV is bidirectional (i.e. individuals who experience IPV are at higher risk for acquiring HIV while HIV-positive individuals are at higher risk for experiencing IPV), and stressed the importance of addressing the two in conjunction [5].

In light of the growing interest in the areas of IPV and HIV, there is still significant progress to be made about addressing both issues simultaneously. Studies have shown that combining intervention techniques can help reduce both continued IPV and risk of acquiring HIV [6-8]. An example of a combination intervention is a relationship-based model in which participants discuss their current relationship sexually,

and emotionally [6]. This type of counseling allows participants to recognize the behaviors and environment of the relationship, in order to assess what aspects are potentially risky or unsafe. Integration is an important way to help mitigate the issue of IPV and HIV among women. Therefore, by locating integrative and non-integrative services, we can help assess whether an area which has high IPV severity and high HIV prevalence have access to adequate services at the community level.

Geospatial mapping is an important tool to help visually identify areas that are greatly affected by IPV and HIV, and identify the demographic makeup so we can better understand the characteristics of the populations are most affected. Additionally, geographic mapping will enable us to evaluate whether HIV prevention resources that integrate IPV counseling services are located in areas of greatest need.

Goals, Aims & Objectives

Goals

- The findings from this study will contribute to a more in-depth understanding of IPV and HIV, and access to integrative resources at the community level in Atlanta
- The results will be used to inform HIV counseling providers where services are really needed for those suffering from IPV the greatest.

Aims

- The first aim of this study is to assess the distribution of HIV prevalence and the distribution of IPV study participants within Atlanta, GA.
- The second aim of this study is to evaluate the geospatial overlap of IPV severity and HIV prevalence. For example, toidentify where the high-high IPV and HIV clusters are compared to low-low IPV and HIV clusters in Atlanta, GA.
- The third aim of this study is to locate which community-based resources address violence and mental health at the HIV testing and counseling session. Then, evaluate the proximity to resources among the clusters of high-risk IPV/HIV populations.

Objectives

- Describe the geographic prevalence of HIV in Atlanta using ArcGIS 10.2.2, and map the distribution of study participants with data collected from AIDSVu and an Emory University study, respectively.

- Identify and map using ArcGIS 10.2.2 geographic areas with high and low severities of IPV measures and prevalence of HIV.
- Identify which community-based resources incorporate some violence and/or mental health counseling into their HIV counseling session. Map these resources using ArcGIS 10.2.2 to identify where they are in relation to high risk IPV/HIV populations in Atlanta.

Study setting & population

In the context of the United States, the prevalence of HIV is predominately concentrated in low-income, less-educated, minority populations, and is especially present in Southern U.S states like Georgia [9, 10]. From 2000 to 2003, these southern states have witnessed a 35.6% increase in new cases; one-third of them were women [11]. In 2011, 38% of persons diagnosed with HIV were in the Deep South; 23% of the identified HIV positive populations were female, and 57% were African American [12].

In regards to IPV, the majority of survivors affected are women. Particularly in the United States, about 1.5 million women are annually raped or physically assaulted by a partner, and 25-30% have experienced IPV over their lifetime [13, 14]. Therefore, this research takes a unique approach to understanding the relationship between IPV and HIV among women by mapping overlapping frequencies and exploring the distribution of integrative resources to better target areas in need.

Chapter 2: Review of Literature

HIV

By the end of 2013, 35 million people around the world were living with the human immunodeficiency virus (HIV); of the 35 million, nearly 1.5 (1.4 – 1.7) million people died because of AIDS-related illnesses [15]. Approximately two-thirds (71%) of the population living with HIV (2012) is in sub-Saharan Africa [15]. Much of the research and attention has been focused on that particular region; however, the rate of the virus in some United States populations has matched that elsewhere. For example, in Washington D.C, 1 in 16 black men are infected; in New York City, 1 in 40 black men have the virus, and despite the advances, approximately 50,000 new infections occur per year in the United States [16, 17].

Since the 1980's, the United States has made many contributions to the reduction of HIV transmission, such as innovative blood screening techniques, mother-to-child prevention, behavioral interventions for positive sexual health practices (e.g., methadone maintenance, needle exchange programs, condom negations, etc.), and highly active anti-retroactive therapy (HAART) treatment as prevention. However, even with the introduction of anti-retroviral therapy, about 20% of HIV-infected Americans were unaware that they have the virus [17]. This may lead to delayed care and potential increased risk of viral transmission. In the United States, this disease particularly affects certain demographics and geographic areas. Urban areas face much of the disproportionate effects of the widespread infection, particularly because of insular social networks, in which many engage in unprotected sex and injection drug use (IDU) [16].

HIV in the South

The South ranks amongst the highest HIV prevalence regions in the U.S. As of 1990, the "Deep South" (Alabama, Georgia, Louisiana, Mississippi, North Carolina and South Carolina) has not seen a plateau in HIV infection rates; rather, it has experienced continual increases in HIV infections [11]. Culturally distinct from the rest of the United States, these southern states have witnessed a 35.6% increase in new cases from 2000 to 2003; one-third of them were women [11]. In 2011, 38% of persons diagnosed with HIV were in the Deep South; 23% of the identified HIV positive populations were female, and 57% were African American [12]. Additionally, conservative southern politics and profound religious roots have influenced HIV/AIDS health policies. These are exemplified by the abstinence-based sexual health courses taught in most southern schools, therefore perpetuating the lack of knowledge surrounding the issue. Moreover, the dearth of insurance coupled with poverty and scarce health education often compromises the ability of many of these individuals to understand the risk of HIV and seek services. Furthermore, HIV/AIDS is concentrated in low-income communities where African Americans are overly represented. To further elaborate, about half of the African American population in the "Deep South" live below 200% of the poverty line, and is 1.5 times as likely to not have insurance compared to Caucasians in the "Deep South" [10]. With the influences of politics, culture, and economics, the South has failed to meet its goal in reducing HIV transmission, and continues to foster high-risk HIV populations.

HIV and Women

The majority of the cases in the United States occur in certain subpopulations, such as "men who have sex with men" (MSM), minorities (African Americans, Hispanics/Latinos, etc.,), and women. In many ways, the high prevalence of HIV among women has been insufficiently addressed and explored the U.S. [9]. In 2010, 20% of the estimated 47,500 new infections were made up of women; currently, one in four people living with HIV are women [18, 19]. Confined social networks, socio-economic disparities, gender inequalities, and racial differences of these distinct neighborhoods have concentrated the infection further, especially in regards to women [9]. Among women, an estimated 84% of transmission is by heterosexual sexual activity [9, 18]. Women also have a higher physiologic risk of being infected with HIV during unprotected vaginal sex than men due to the larger surface area of exposed mucous membrane [14]. In a national health survey conducted by the CDC, more than 20% of women aged 20 to 39 responded to participating in anal sex [18]. Unprotected anal sex is even risker for women for a couple of reasons. First, the mucous membrane in the anus is exposed, and secondly, there is an increased likelihood of infection because of tissue tearing [20].

Furthermore, African American and Latina women are disproportionately affected. Black women accounted for 66% of HIV/AIDS cases, and Latina women made up 14% of the infected in 2007, yet they only represented 14% and 11% of the entire United States population, respectively [9, 21]. Moreover, people tend to have sexual relations with those in their own community and background; therefore these groups face a greater risk of HIV infection with each new sexual partner [9].

Perceptions of risk also factor into the relatively high HIV rates seen among women. Additionally, women that are unaware of services available may also lack knowledge about the disease, have limited access to resources, societal and familial pressures, and concurrent partners with increased risk of HIV infection [9]. Because of multiple environmental, societal, economic, and political factors, many HIV seronegative high-risk women have trouble adequately accessing and utilizing preventative HIV services.

Intimate Partner Violence

The third United Nations Millennium Development Goal is to promote gender equality and women's empowerment. At the core of that initiative, addressing violence among women has been inadequate, and continues to undermine the achievements in women's health [22]. IPV is the physical, sexual, emotional/mental, and/or financial harm of a spouse, sexual intimate, or former partner [23]. Multiple studies have explored the impacts that survivors of IPV may biologically experience. These studies have suggested that IPV can potentially activate various regulators in the body and promote changes in metabolism and impact some immune functions, which can lead to increased susceptibility of infections and illnesses [24-26]

In recent years, IPV has been receiving more public health attention around the world. In the United States, about 1.5 million women are annually raped or physically assaulted by an intimate partner, and 25% of women have experienced IPV over their lifetime [13, 14]. It is important to note that these measured values are grossly underestimated, as many who experience violence do not officially report it.

Women who experience IPV suffer from a wide variety of mental, physical, social, and financial effects. Additionally, they are found to have higher rates of elective

abortions, poor pregnancy outcomes, chronic pain, and sexually transmitted infections [13]. In the United States, those who experience IPV use the health care system 1.6 to 2.3 times more than women who are not abused. Additionally, the cost of IPV and health care expenditures exceeds $5.8 billion annually; more than 70% of the spending on direct medical and mental health services, resulting in about 2 million injuries and 1,300 deaths annually [13, 23, 28].

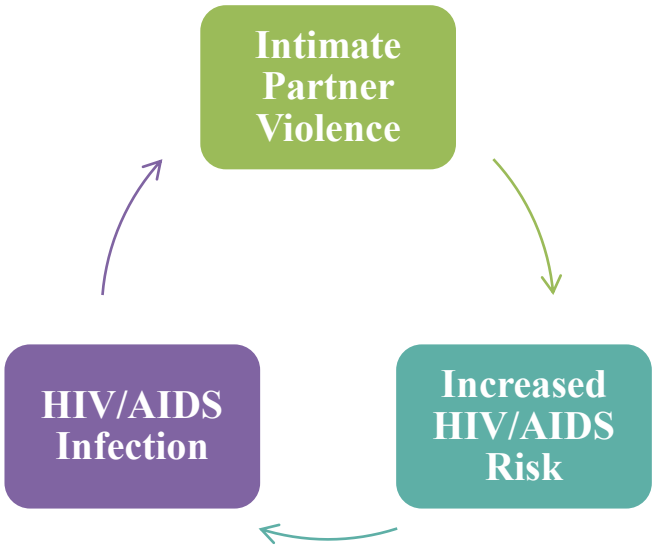
A study conducted by El-Bassel et al., showed that almost half (n=799) of their sample of women who visited emergency departments experienced some form of lifetime violence (i.e. sexual, physical, emotional) [29]. Furthermore Kramer, Lorenzon, and Mueller researched women seeking services in primary care and emergency departments (n=1,268). They discovered that over 80% of women reported physical and emotional lifetime abuse, and over 40% reported sexual abuse [30]. As part of the survey, 83% of the women welcomed questions about violence given it was confidential, and of those who did experience lifetime violence, 58% said they would disclose their abuse to a physician or nurse [30]. The study suggests that there is willingness from the public to talk about these issues and seek services. Therefore, it is increasingly important to understand how to integrate IPV prevention initiatives into various community resources (HIV counseling centers, emergency departments etc.,).

HIV and Intimate Partner Violence

IPV can act as both a precursor and consequence of HIV. Women who are experiencing IPV are at higher risk for acquiring HIV and other sexually transmitted diseases [9, 29, 31-36]. The CDC reports that women with histories of experiencing sexual abuse are more likely to engage in risky behaviors (transactional sex, illicit drug

use, unprotected sex) than those who did not experience any abuse [18]. Other potential reasons for the increased risk of HIV among survivors of IPV include: sexual coercion, drug abuse (e.g. injection drug use), concurrent relationships, lack of safe sex negations (e.g. condom use), and transactional sex [24, 37-40]. Diagram 1 shows the cycle of IPV and HIV/AIDS that we see in the literature [41].

Diagram 1: Cycle of intimate partner violence, HIV/AIDS risk, and HIV/AIDS infection and transmission. Adapted from Dawson, L. and J. Kates, *HIV, Intimate Partner Violence (IPV), and Women: New Opportunities Under the Affordable Care Act (ACA)*. 2014, Kaiser: The Henry J. Kaiser Family Foundation



Many studies comparing IPV prevalence among seropositive and seronegative HIV populations have been conflicting, with some showing higher frequencies of IPV in HIV+ populations and others showing no association [32, 38, 42-46]. One study conducted by Sareen, Paguru, and Grant found that about 12% of the HIV infections in their U.S based study were attributable to women experiencing violence (n=13,982; data from the National Epidemiologic Survey on Alcohol and Related Conditions) [14]. These notable ranges may be due to a multitude of reasons, some of which are: limited investigations available on the prevalence of the combination, underreporting, variations

in IPV scales used, and various reporting sources. Therefore, the reported prevalence may be higher in reality. Furthermore, because IPV is prevalent in HIV high-risk populations and linked to increased engagement in HIV risk behaviors, it is imperative to continue to see how these two issues can be mitigated.

Violence can obstruct a women's capability to be assertive sexual decision-making to protect themselves from the risk of STIs and HIV [20, 40, 47]. A longitudinal study conducted by Wyatt et al., investigated how history of abuse can contribute to HIV related risk factors [47]. The researchers sampled HIV seropositive (n=299) and negative (n= 158) women of three ethnic backgrounds: African American, European American, and Latina. Of the sample, 49% reported having more than 5 sexual lifetime partners, 49.2% having one or more STIs, over 49% were sexually abused, and over 51% were physically abused [47]. These findings, along with studies conducted by Campbell and El-Bassel et al., suggest that abuse and its association with risky sexual behaviors confers a higher probability of acquiring the HIV infection [24, 31, 47].

Furthermore, high levels of stress and depression due to physical and psychological violence may result in less receptive immune responses that can increase risk in acquiring the HIV infection [26, 40, 48]. A study conducted by Raison, Capuron, and Miller investigated what immune response markers are affected by depression. Their findings show that many inflammatory markers are elevated compared to persons who do not experience depression [49]. Increased inflammatory functions for a prolonged period of time, reduces the effectiveness of the immune system. Additionally, another study conducted by Constantino, Sekula, Rabin, and Stone examined the relationship between immune systems, depression, and negative life experiences among abused women and

non-abused women [3]. Their findings suggested that compared to non-abused women, women who have experienced violence had diminished T-cell functioning.

Lastly, Wyatt et al., revealed that HIV prevention programs do not sufficiently address abuse and sexual negotiations, and that a limiting factor in women's control over reducing their HIV risk was their economic situation [47]. Furthermore, another study conducted by El-Bassel et al., investigated how efficacious relationship-based HIV/STD programs can be for the clients [6]. The study sampled heterosexual couples (n=81) and women alone (n=63) to find that regardless of how the intervention was received (together or alone), relationship-based programming increased safe sex practices. Relationship communication, negotiation, problem-solving skills, expectations, and relationship dynamics were empathized in this intervention [6]

HIV and Intimate Partner Violence prevention services: A need for integration

Few studies have examined the intersection of HIV and IPV interventions [6, 23, 29, 35, 50]. Many HIV intervention programs may discuss the use of condoms and reducing concurrent relationships, however, they fail to take into account those women who have experienced violence, and the difficulties they encounter to try and implement these strategies in their life [35]. Moreover, many women are afraid to expose their status to their partner because of potential violence. Patients who participate in testing and counseling programs that do not incorporate an assessment of their relationship, may be at an increased risk of exposure to violence [35]. Therefore, incorporating common areas of HIV/IPV could greatly benefit HIV and IPV prevention programs. However, further

investigations into the specific resources and programs in the Atlanta area are needed to better assess how these issues have been handled.

Geographic Information Systems

Geographic Information Systems (GIS) is a tool used in a variety of fields to analyze spatial, geographic, topological, and descriptive data. The end result aims to link people to places and represent information through the use of vivid visuals [51]. In public health, professionals can gain an understanding of how relationships between geographic, economic, social, political and demographic factors can affect health outcomes. Using maps and graphics, GIS can tell a story about the health outcomes in a unique and simplified way compared to other data presentation techniques. The software encompasses various spatial analytical techniques e.g. buffer analysis, network analysis etc., [52, 53]. Some topics of interest could include: identifying distinct communities, disease tracking, pinpointing health service locations, and/or performing a distance analysis to understand access to health services in various settings [52].

GIS software can be used in these various pathways, including: disease surveillance, health planning and access, and community health profiling [51]. Disease surveillance is used to understand the distribution and spread of the disease. It has proven to be an effective tool because it can facilitate the development of interventions in identified areas, plan interventions, assess populations at risk, evaluate health outcomes, routine monitoring, recognize disease patterns, and make model for future predictions [54].

In health planning, network analysis and market segmentation can be done to better select potential service locations that offer greater access to at risk populations in

areas lacking those particular health services. Identifying areas where public transportation is lacking or what types of programs are available in the area can help public health professionals tailor interventions and services. Additionally, providing a visual representation and list of services can help the general public easily identify resources, and aid policy makers, and health care providers effectively target effective interventions [51].

Community health profiling is mapping information regarding health characteristics of the population. These include socio-demographic factors, health behaviors (e.g. drug use, condom use), and disease morbidity and mortality. These variables can be linked to the spatial setting (e.g hospitals, clinics, centers) to provide a general relationship between health and the surrounding environment [51].

The use of GIS software and these general themes can be advantageous when looking at relationships between IPV and HIV. These themes can document and visually represent the current state of HIV in Atlanta, identify high-risk IPV areas, and visualize potential services to incorporate strategic interventions by understanding the neighborhood characteristics.

Spatial Relationship with HIV in Atlanta

Ranked 8th in the nation for reported number of AIDS cases (100,000 populations), Georgia has one of the highest rates of HIV/AIDS. The Georgia Department of Public Health found that barriers to knowledge, care, prevention, and intervention services are still stagnant despite the increased funding received for HIV/AIDS services [55]. A cluster analysis of HIV/AIDS cases in Atlanta found that

60% of diagnosed HIV/AIDS individuals lived in Fulton and DeKalb counties of metro Atlanta [55].

Metropolitan Atlanta is comprised of 31 counties; however, the city of Atlanta is within two counties, Fulton and DeKalb counties; 55.8% of the population is African American and 21.8% live below the poverty line [55]. The Ryan White Care Act has enabled many HIV/AIDS services to reach the lower income bracket with medical, dental, mental health, transportation, alternative therapies, and other support services [10, 11]. Spatial distribution of infected persons and characterizations has been, by in large, under-investigated. Some studies have theorized that community level characteristics, (i.e., household income and race) can affect social and financial dynamics that can impact the transmission of HIV [55]. Understanding these trends will guide policymakers and public health professionals to create more effective programming within the identified areas.

GIS and IPV, and Gaps in Literature

GIS has rarely been utilized to map locations of IPV occurrence. Reasons for this include: 1) Survivor's sensitivity and potential violation of confidentiality, 2) the absence of spatially linked IPV data to understand geographic distribution of cases, 3) the sources of violence reporting varies (i.e. police departments, emergency rooms, primary care offices, and research surveys), and 4) a lack of standardization of instruments used to assess IPV. Additionally, locations of violence shelters are rarely publically available, in order to ensure privacy and protection of those who utilize the facilities.

To our knowledge, only one study has reported geospatially-mapping violence against women. It was conducted in the United Kingdom, has and was able to provide a

deeper spatial understanding of the issues at hand by looking a local authority level services and migratory patterns of survivors fleeing to a new location [56]. However, there is a lack of literature surrounding the linkages between IPV and space among women in the US. Furthermore, to our knowledge, no additional research has been conducted to spatially evaluate whether IPV resources are concentrated appropriately in areas in which HIV and IPV frequently co-occur. Lastly, there's a lack of geographically informed allocation of IPV/HIV integrative services in Atlanta.

This project aims to understand the spatial relationship between IPV and HIV in metropolitan Atlanta. By comparing the demographic makeup of neighborhoods with high and low IPV and HIV overlap, the study can contextualize what features may place persons at risk for both HIV and IPV. Using spatial software, such as ArcGIS, resources can be mapped to analyze access and proximity of types of services available. Additionally, this software can help link these relationships, which can guide public health professionals to understand where services are lacking, and how to incorporate better-targeted interventions.

Chapter 3: Manuscript

Contribution of Student

The work herein is product of secondary data analysis performed by the student. The student participated in the construction of the survey and collection of data related to the intimate partner violence study under the guidance of Ameeta Kalokhe. The student performed analyses independently, including descriptive analysis of data, construction of spatial methodologies and analysis, production of diagrams, tables, graphs, and maps, and all writing. The student's primary thesis advisor (Ameeta Kalokhe, MD, MSc), and other faculty members of Emory University (Neela Goswami, MD, MPH; Julie Clennon, PhD) provided advisement throughout this process.

Abstract

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Author: Neetu Hariharan, MPH

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Conclusions: Our results suggest that geospatial mapping can be useful to identify regions of high IPV severity and high HIV overlap and to classify geographic gaps in allocation of HIV prevention and IPV community support services. Overall, this study serves as a platform to continue the exploration of spatial tools to address nontraditional socio-behavioral risk issues in research, and contribute to policy and resource discussions.

Introduction

According to recent World Health Organization estimates approximately 35 million people worldwide are living with the human immunodeficiency virus (HIV) [1]. While the majority of these persons reside in sub-Saharan Africa (71%), the Centers for Disease Control and Prevention (CDC) reports that 1.2 million people are living with HIV infection in the United States [1, 2]. The prevalence of HIV in the U.S. is predominately concentrated in low-income, less-educated, minority populations, and is especially present in Deep South, which includes Alabama, Georgia, Louisiana, Mississippi, North Carolina and South Carolina [3, 4]. In 2011, 38% of persons diagnosed with HIV were in the Deep South, 23% were female, and 57% were African American [5].

Intimate partner violence (IPV), defined by the CDC as experience of "physical, sexual, or psychological harm by a current or former partner or spouse", has emerged as a key driver of HIV risk among women [6-18]. In the United States, approximately 1.5 million women report being raped or physically assaulted by an intimate partner annually. One-third report experience of physical or sexual abuse and/or stalking by an intimate partner over their lifetime [19]. In a recent nationally-representative cross-sectional study of 13,928 women, women who experienced IPV were 3.4 times more likely to be HIV infected, with 12% of HIV infections being attributable to IPV [15]. The increased HIV risk incurred by survivors of IPV can in part be explained by their increased likelihood of engaging in risky behaviors (i.e. transactional sex, illicit drug use, and unprotected sexual intercourse) and having sexual partners with increased HIV risk [12, 18-22].

Though the link between IPV and HIV is well established in the literature, to our knowledge no one has yet evaluated the geospatial overlap of the two epidemics. Geographic information systems (GIS) software and other spatial tools have been leveraged in various ways to understand the distribution and spread of disease, select potential service locations that offer greater access to at- risk populations, and to profile the epidemiology of a disease in a community [23]. We hypothesized geospatial mapping could be valuable in further exploring the relationship between IPV and HIV by visually demonstrating the geographic overlap of the two epidemics in a community, by providing insight into the demographic and neighborhood characteristics of areas where both are prevalent, and by highlighting geospatial gaps in community support services. Ultimately, this information could help tailor and allocate the community distribution of future integrative HIV and IPV prevention interventions.

This paper aims to explore the utility of GIS in exploring the geospatial clustering of IPV severity and HIV in metropolitan Atlanta, Georgia, and in evaluating whether HIV testing and counseling centers acknowledging provision of violence and mental health services overlap with the high-prevalence geographic clusters. Insights from this study may help further advocate for the integration of IPV interventions in HIV counseling and testing sites, and identify geographic areas of greatest need in Atlanta, GA.

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Methods

Study Setting and Design

In this cross-sectional study, we describe the spatial overlap of IPV severity among women identified as high-risk for HIV and prevalent HIV infection in the metro-core Atlanta area.

Metropolitan Atlanta is comprised of 31 counties; however, the city of Atlanta is within two counties, Fulton and DeKalb; 55.8% of the population is African American and 21.8% live below the poverty line [24]. Clayton, Cobb, DeKalb, Fulton, and Gwinnett counties will be the counties of focus to comprise "metro-core" Atlanta. The target population for the study was women at high risk for HIV and residing in Clayton, Cobb, DeKalb, Fulton, or Gwinnett counties.

Data sources

Intimate Partner Violence Data

We obtained IPV data from a cross-sectional study conducted on IPV and HIV risk in metro-core Atlanta ('The IPV and Biological HIV Risk Study' (IBHRS)), which aimed to evaluate whether the increased HIV risk incurred by IPV survivors could in part be due to stress-induced immune changes. The study team received specialized IPV training in regard to sensitivity, confidentiality, safety, and referral to properly conduct the study and make sure the participants felt safe and comfortable, and methods to refer participants to IPV support services. For the IBHRS study, 85 participants were enrolled between March and November 2014 using convenience sampling. Participants were recruited through flyers placed at various, community centers, churches, informative presentations, college campuses, referrals from HIV prevention trials, and through word

of mouth. Eligibility criteria for the study included being a woman age 18-50 years, residence in Atlanta, being high risk for HIV, HIV-negative and not pregnant. 'HIV high-risk' was defined as an affirmative response to one of the following risk behaviors in the prior 5-year period: drug use (IVDU, cocaine, crack, and methamphetamines), sexually transmitted infection (STI) diagnosis, unprotected sex with over four men, protected or unprotected sex with over six men, sex with a known HIV positive man, transactional sex for drugs, money, or shelter, or sex with a partner who met any of the above criteria.

Participants underwent a 60-90 minute one-on-one interview consisting of demographic, IPV, and health behavior questions. IPV experience was assessed using two scales: The Severity of Violence Against Women Scale (SVAWS) and Index of Psychological Abuse (IPA) [25, 26]. The 46-item SVAWS scale (Chronbach's $\alpha = 0.92 < \alpha < 0.96$ for female college students, and $0.89 < \alpha < 0.96$ for community women) was used to evaluate experience of physical and sexual abuse [25]. The Index of Psychological Abuse is a 33-item scale that measures emotional or psychological abuse (Chronbach's $\alpha = 0.97$) [26]. A combination of SVAWS and IPA scores was used to determine severity of IPV over 12 months and a lifetime. Each participants degree of severity of abuse experienced were calculated using these scales. A score ≥ 85 was considered to be high IPV severity and a score ≤ 84 is considered to be low IPV severity.

The Emory University Institutional Review Board and Grady Health System Research Oversight Committee approved the IHBRS and use of the data for the geospatial substudy. Informed consent for the IHBRS study was obtained in-person from

each participant before the interview began. Subsequent verbal consent over the phone was obtained to approve use of the participant's address for this substudy.

HIV Surveillance Data

AIDSVu is an online interactive map (aidsvu.org) illustrating HIV prevalence in the United States alongside critical resources such as HIV testing centers and treatment sites [27]. Residential addresses for persons living with HIV were collected from AIDSVu, which collects HIV incidence and prevalence data for Atlanta from the Centers for Disease Control and Prevention's (CDC) national HIV surveillance database, and data from state/local health departments [28].

All Atlanta HIV cases entered through December 13, 2013 were collected, de-identified, and aggregated into their respective ZCTA to ensure confidentiality of the participants. Estimated rates of persons living with an HIV diagnosis were calculated per 100,000 populations for standardization and comparison [28]. Supplemental demographic data were obtained from the 2010 census bureau [29]. Stata 13.0 was used for data analysis. No additional manipulation or geocoding processes were made to the data obtained from AIDSVu.

Care and Counseling Resources

HIV testing and counseling centers were identified using multiple sources including the National Prevention Information Network (NPIN), The Southeast AIDS Training and Education Center (SEATEC) key contacts summary of Georgia, AIDSVu online HIV resource locator, and the Georgia Care and Prevention in the United States (CAPUS) online HIV resource locator [30-33]. These sources helped to comprise the semi-comprehensive list of resources in the identified metro core Atlanta area (n= 24).

Resources that incorporated violence or mental health were identified by an informal phone call and confirmation whether or not their community based HIV testing and counseling sessions included any violence/mental health identification or prevention measures.

Spatial Analysis

Geocoding and Mapping

All shapefiles for county and zip code tabulation area (ZCTA) boundaries were obtained from the Atlanta Regional Commission. ArcGIS 10.2.2 was used to map prevalent HIV and IPV severity in metro core Atlanta. Automated geocodes for IPV severity were obtained by matching addresses using an ESRI 2012, US Street Locater in ArcGIS 10.2.2. The process began with loading a comma separated value (CSV) file into the program, and running the locator. The addresses are compared to the segmented address field in the CSV to the locator file [34]. The program matches each address on the basis of a "match score", scaled from 0 to 100 (perfect matching). Criterion for the match score can be set, in which 100% matching was the goal. No positional offsets from the street centerline were used during the calculation. As a result, 85% (n=66) of the addresses met the 100% criterion match. A rematch was performed, and 12 of those unmatched addresses were found to have small errors in the way they were written; such as, "St." instead of "St" or "Northwest" instead of "NW"; only 1 address was not located, therefore it was removed from further analysis and the final sample size was 78.

In order to ensure the privacy of participants in the IPV study, the geocoded addresses were then manipulated and weighted to fall in a central point in the census block ("jittering"), thus reducing their risk of identification on a secure server in a secure

lab[35]. A major objective of the study was to describe the spatial distribution of IPV survivors in the context of HIV prevalence in their ZCTA and in relation to adequate resources. Hence, the necessity of using altered point addresses in a small census group instead of aggregating to a larger geographic unit. After jittering the coordinates, all associated addresses with identification numbers were deleted to safeguard privacy while continuing analysis.

Using the ESRI 2012, US Street Locater in ArcGIS 10.2.2, community-based HIV testing/counseling centers were mapped after IPV/HIV analysis (100% criterion match (n=24)). Points were distinguished by whether they had violence/mental health components to their HIV counseling or they had no components of violence/mental health.

The North American Datum (NAD) 1983 and FIPS West 2001 projection was used in all frames of the program. Once shapefiles of the metro-core Atlanta, county lines, zip code boundaries, IPV data, and AIDSVu data were loaded, demographic, IPV severity, and HIV distributions were created using a combination of density dots and chloropleth maps.

Cluster Analysis

Kernel density analysis was used to characterize the overall spatial distribution and clustering of study participants. The weighted K-function, using a Point Pattern Analysis (PPA) tool, was used to determine the distance at which IPV clustered (if at all) within the given search radius [36]. This allows for a global clustering trend analysis to understand if there is a general level of clustering associated with IPV over the past 12 months and over a lifetime. Therefore, it will determine at what distances high-recorded IPV severity (IPV score ≥ 85) will cluster, as the same with low-recorded IPV severity

(IPV score ≤ 84). The following parameters were used during the analysis: 22,000ft distance, intervals of 10, and 99 permutations. Additionally, a Ripley's K function analysis of IPV participants, using PPA, was used to determine if the weight K-function was driven by severity or location by comparing the differences in observed output values.

The Getis-Ord G* statistic tool (Hot spot analysis) in ArcGIS 10.2.2 was used to identify hot spots of IPV overlaying HIV prevalence areas in Atlanta within the distance found in the weighted K-function analysis. The Getis-Ord G* statistic takes neighboring values, and determines whether identified clusters are significant within the local frame [37, 38]. The distance used to run the hot spot analysis was based using distances found in the weighted k-function analysis, and the hot spot optimization tool. The output will show the central clustering points.

A confirmatory analysis was performed with Kulldroff scan using SaTScan 9.4 to verify the set distances and identified clusters. A Kulldroff scan tests for clusters using local spatial rates and an ordinal model defined by the continuous variables. The software then scans the area using a circular shape to identify high and low values without a defined distance [39, 40].

Distance to Resources Analysis

To characterize proximity of IPV severity clusters to relevant resources, a buffer analysis was performed. A buffer analysis at 400ft, 800ft, and 1600ft was set to determine the area around the resources. A spatial join was then separately done with each of the two IPV severity variables to determine the closest resource to a participant.

Results

Local conditions in the environment can be an important tool to discuss future public health planning and policies [41]. Specifically in regards to geographical patterns of IPV and HIV, it is important to visualize the geographical overlap and to assess whether there are adequate support services in areas where there is significant burden of both IPV and HIV.

Demographics of Atlanta

Five counties define metro-core Atlanta, shown in Figure 1. The two most densely populated counties are Fulton and Gwinnett [42]. Table 1 further details the demographics of each county. IPV data from IBHRS included only 73 of the initial 85 participants for this study as 4 did not meet inclusion criteria 3 did not consent to this substudy, and 5 were identified as outliers by initial spatial visualization of the spread.

Results for Intimate Partner Violence Data

Descriptive statistics of IPV participants stratified by marital status are provided in Table 2. Fifty-six percent (39/71) of our participant pool identified as single, separated, or divorced. Ages among the participants were mostly evenly spread through the three defined group. The majority (59/73) identified as Black/African American, had obtained at least a high school diploma (68/73), and reported an income of less than $10,000 per year (56/73). Among those who identified as single/separated/divorced (n=39), 31 participants had experienced homelessness in the past, and 25 participants who identified as married/in a relationship (n=34) had the same experience. About 80% (58/73) of women were tested for HIV at least once from 2012-2014. About 75% of single, separated, or divorced women and 91% of married or intimate relationship women

reported unprotected sex with more than 3 men, in the past 5 years. Lastly, about 80% (58/73) of the women had engaged in intercourse with a man who has participated in at least one high-risk behavior (e.g., unprotected sex, previous STI, transactional sex, slept with an HIV+ individual). Figure 2 demonstrates a spatial depiction of reported IPV severity in metro-core Atlanta. Over 12 month IPV severity, the median for low severity was a score of 34.50 (IQR: 55) and the median for high severity was a score of 121 (IQR: 42). Over lifetime IPV severity, the median for low severity was a score of 58.5 (IQR: 71) and the median for high severity was a score of 175 (IQR: 52).

Results for AIDSVu HIV Data

Table 3 describes statistics of HIV/AIDS surveillance data stratified by counties from the AIDSVu study. About 48% and 30% of diagnosed HIV/AIDS cases are in Fulton and DeKalb County, respectively. The overall prevalence of diagnosed HIV/AIDS among males was 1,847 per 100,000 populations and females were 311 per 100,000 populations. In metro-core Atlanta, prevalence of diagnosed HIV/AIDS individuals is black (1,352 per 100,000 populations). The overall prevalence amongst age groups is most predominant between 35-44 and 45-54 groups. Of those diagnosed with HIV/AIDS, on average, 27.3% in Clayton County, 25.8% in DeKalb County, 24.5% in Gwinnett County, 22.9% in Fulton County, and 19.8% in Cobb County are uninsured.

Kernel Density and Weighted K-Function Estimates

Kernel Density estimates of IPV participants is shown in Figure 3. The highest density of IPV participants is predominantly within the following zip codes located in either Fulton and/or Dekalb County: 30307, 30310, 30314, 30318, and 30354. The weighted K-function analysis is a method introduced by Ripley for generally testing

clustering in a point pattern. It measures how many events happen within a specified distance of other events based on particular factor. Both IPV severity over the past 12 months and lifetime were individually analyzed. Graph 1 and 2 describes the global clustering trends of both IPV severity measures at 22,000ft (4.17mi). For reported IPV over the past 12 months, there was no global trend of clustering within 22,000ft; however for reported IPV over a lifetime there was significant clustering from 4,200ft (0.80mi) to 11,000ft (2.10mi) (*p-value* $< 0.05, \alpha=0.05$). Additionally, a difference in L(d) values of between the weighted k-function and Ripley's k-function shows that the outcomes in both severity measures are not driven by spatial location from 2,200-13,200ft.

Getis G-Ord Estimates and Kulldroff's scan*

A Kulldroff's scan, implemented using SaTScan software, tests for clusters using local spatial rates defined by circular shapes using an ordinal model for scanning the continuous IPV 12-month and lifetime severity measures [39, 40]. Figure 4 details the resulting SaTScans at a *p-value = 0.04* and $\alpha=0.05$ with no specified scanning distance. From Figure 3, both scans (12 month severity and lifetime severity measures) demonstrate that the high and low severity are located in the same position.

The resulting Getis G-Ord* hot spot analysis found 2 hot spots for both lifetime and past 12-month IPV severity, but 4 cold spots for IPV severity over the past 12 months, and 5 cold spots for IPV severity over a lifetime as shown in Figure 5. The best distance of analysis was determined to be 23,750 ft, given the spatial spread of the data and the optimization tool. The appropriate z-value (*z-score*$=|3.17|$) was based off the number of observations in the data set under an $\alpha=0.05$ to reduce type 1 error during the analysis.

Geographic Gaps in the allocation of Integrative HIV & IPV Community Resources

Of the 24 identified community-based HIV counseling and testing centers, 9 did not report having any IPV/mental health incorporated into their HIV testing/counseling sessions, and 9 were identified as having some IPV/mental health incorporated into their HIV testing/counseling sessions. The remaining 6 neither confirmed nor denied that resource. Therefore, a total of 18 resources were examined in conjunction with the two IPV severity measures. Usually, people are willing to walk around 400ft (0.25mi). The upper limit for walking distance is around 800ft (0.50mi), and for an extreme example 1600ft (1mi) [43-45]. The resulting maps (Figure 6) show buffer rings around the resources at those specified distances for 12 month IPV and lifetime IPV. The resulting figure describes how close a participant is to a resource and which participants are within walking distance given they reside within the buffer.

Discussion

IPV and HIV are syndemic and require integrated prevention services. In a time where public health funding is limited [47-49], a directed approach to the allocation of such community support services is vital. The newly enacted Affordable Care Act (ACA) has now been able to make some headway in impacting health of IPV survivors. Now insurers can no longer deny coverage to anyone who is a survivor of IPV [50]. Additionally, screening and counseling for IPV is a preventative measure under the ACA, alongside HIV testing/counseling [50, 51]. This study demonstrates that geospatial tools are suitable and effective in exploring the geographic overlap of IPV experience and HIV as well as investing gaps in integrative IPV and HIV preventive services.

Although clustering analyses are well suited for environmental disease ecology [52], this study has demonstrated that they can be used in nontraditional scenarios. Our study was among the first to use spatial components to understand IPV, in addition to the only one other known study published in 2011 by Coy et al. [53]. That particular study researched mapping violence services in the United Kingdom (U.K) and journeys of women feeling from abusive situations [53]. The first part of the study used spatial tools to map the resources by local authority levels. All subsequent analyses were done using these local authority levels, and by identifying the density of women and the number of women served by each violence against women (VAW) service. The second part of the study followed 550 women who had relocated somewhere in the U.K because of IPV. They were able map the journeys by Euclidian distance, mainly to understand how far they traveled to reach a common destination [53].

One of the main differences in our study is the exploration of IPV in high-risk HIV areas to understand resource gaps, and the potential for service integration in existing community-based services. Both studies took precautions in masking the data. While the Coy et al. (2011) study standardized the results to local boundary levels, our study decided that through randomization within census blocks, we could effectively disguise the data [53]. Additionally, this method can provide a more accurate depiction of IPV and severity levels in relation to HIV high-risk areas. Furthermore, their utilization of Euclidian distance effectively communicated how far an individual is from a source, which is how our study depicted resource access.

Generally, participants were located around the central eastern areas of Fulton County and the central western areas of DeKalb County. Additionally, these areas have high rates of diagnosed HIV/AIDS [25]. Therefore, the participants are potentially at higher risk of being exposed to HIV/AIDS compared to individuals who live further away from the areas.

Global clustering trends were found only when looking at lifetime IPV severity; however the lack of clustering does not indicate that there is not any local clustering. Local clustering was examined by two k-function analyses. The difference in observed L(d) values identified that clustering was not dependent on spatial location, but rather weighted by severity. Further analyses were done to isolate the areas where we see local clustering trends. Both hot and cold spots showed that local clustering occurs in high HIV prevalent areas, therefore there is clear overlap in the spatial distributions of these problems, providing geographic support for a known epidemiologic relationship between the two.

Finally, once the resources were mapped, the one-mile buffer only encompassed some IPV participants. However, even though we see that majority of the individuals live more than a mile away from these resources, it is unknown how burdensome that distance can be. One example that exemplifies distance in relation to access is a randomly sampled cross-sectional study conducted by Leibowitz & Taylor (2007) concluded that when testing sites are further away, those with low income are less likely to get tested [54]. Likewise, focus groups expanding on the issues of perceived barriers to HIV testing among women living in the 'Deep South' identified that distance to centers, and lack of personal transportation in addition to inadequate public transportation makes the commute difficult [55]. Given that majority of the IBHRS study participants have an income less than $10,000 per year and poor transportation options, proximity to these resources can be a driving factor to the utilization of these services. For that reason, because our study identifies that majority of the resources were located in high HIV prevalence areas, these are optimal locations to start to integrate IPV/mental health resources.

Limitations

Our study is not without limitations. The cross-sectional nature of the IPV and HIV data do not allow for causal inferences. The small sample size and our use of a convenience sample limit the generalizability of demographic and spatial findings. Additionally, using a small data set in conjunction with a small area, ecological fallacy is an important concern. Area level associations, though interesting, may not be representative of individual level conclusions. Due to the small sample size, and only using segments of the validated scales, it is not a definitive measure of IPV cases that can be used in estimating prevalence. Additionally, combining various scales to determine

severity is a limitation because of varying measures within the scale, and dissimilar weights associated with the calculating IPV scores for framing severity levels. Lastly, by jittering the IPV data points to the centroid of the census block, this can potentially obscure and weaken the results from the clustering analysis, given the small sample size. Nonetheless, because of the sensitivity of the subject matter, this was the best approach and should be applied in future studies to protect the identity of IPV survivors.

HIV/AIDS data obtained from AIDVu was limited to ZCTA and county level data. Due to ZCTA areas crossing bounds between county lines, some error exists in the displayed rates. Another inherent limitation is the sparse nature of the data covering a relatively large area; leading to limited precision of the statistical tests. However, this dataset still provides important knowledge about HIV/AIDS rates in Atlanta.

Additionally, a strong attempt was made to identify integrative community-based HIV testing and counseling centers using phone interviews, but ultimately not every resource was captured. There still remains a gap in not only how many community-based HIV testing centers exist, but the extent of IPV and mental health counseling services they offer. Lastly, our analyses only examined the closest Euclidian distance to a resource. Though these points exemplify that participants are closer to one location than the other, the true distance can differ depending on the road networks. However, this is still a useful measure in understanding resource accessibility and distribution.

Conclusions

Nonetheless, our study demonstrates that geospatial mapping has utility in evaluating the geographic overlap of HIV and IPV and identifying geographic gaps in community-based integrative support services. The outcome of this and subsequent spatial analyses can be used to provide insight to community-based organizations, researchers, and other public health agencies about local clustering of IPV and resource distribution utilizing existing HIV services. We demonstrated the usefulness of spatial tools to heighten understanding of a nontraditional subject in relation to space. Therefore, it is recommended t further studies be done with a larger dataset that includes various IPV outcomes, to explore different facets of the topic; such as migratory trends of IPV survivors, intersections in drug use and violence, violence among children, etc.

Moreover, in regards to understanding resource distribution and allocation, more efforts should be placed in developing a fully comprehensive list of community-based HIV testing and counseling centers that detail useful IPV and mental health resources. Lastly, though the findings of this study are not generalizable, the methods provide a mean to address resource disparities and sheds light onto IPV issues to induce potential policy and healthcare changes.

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Appendices

Appendix A: Tables

Table 1: Demographic characteristics of the population in 5 counties of Atlanta, GA

Characteristics	Clayton	Cobb	DeKalb	Fulton	Gwinnett
Population*	259,623	690,063	692,902	926,197	808,719
Male	124,364	335,373	331,942	451,082	398,949
Female	135,259	354,690	360,960	475,115	409,770
Race*					
White	36,610	169,020	12,839	35,447	5,508
Black	387,438	168,053	30,432	84,330	17,825
Hispanic	140,943	4,287	10,875	16,550	2,856
Age*					
10-29	80,194	191,470	200,075	273,646	229,370
30-34	59,639	159,713	164,858	216,062	193,531
45-64	59,637	179,142	169,035	223,358	198,375
65+	17,236	59,972	62,228	83,424	55,105
Poverty Estimate**	57,649	95,398	131,946	159,048	109,745
Percent Poverty (%)**	22.6	14.0	19.4	17.7	13.6
Median Income (USD)**	$36,595	$59,471	$47,068	$53,580	$57,848

*U.S. Census Bureau. Population Estimates, State Intercensal Estimates (2000-2010) [entire data set]. Published October 2012.

**U.S. Census Bureau, Small Area Income and Poverty Estimates, Table 1: 2010 Poverty and Median Income Estimates – Counties. Release date: 11.2011

Table 2: Various Characteristics of IPV Participants ‡

Characteristics of IPV Participants	Single/divorced /separated (n=39) (%)	Married or in an intimate relationship †† (n=34) (%)	Overall (n =73) (%)
Age			
19-29	17 (43.6%)	8 (23.50%)	25 (34.25%)
30-39	12 (30.80%)	13 (38.25%)	25 (34.25%)
40-50	10 (25.60%)	13 (38.25%)	23 (31.50%)
Race† (missing, n=2) †			
Black/African American	27 (73%)	32 (94%)	59 (83%)
White/Caucasian	10 (27%)	2 (6%)	12 (17%)
Education Level			
Less than the 9th grade	2 (5%)	3 (8.80%)	5 (6.85%)
9th grade to High school diploma	15 (38.5%)	17 (50%)	32 (43.85%)
Education beyond High school	22 (56.50%)	14 (41.20%)	36 (49.30%)
Income Level			
< 10,000	31 (79.50%)	25 (74.5%)	56 (76.75%)
10,000-19,999	7 (8%)	8 (23. 5%)	15 (20.50%)
20,000-39,999	1 (2.50%)	1 (3%)	2 (2.75%)
> 40,000	0 (0%)	0 (0%)	0 (0%)
Homelessness			
Currently homeless	5 (12.80%)	3 (8.85%)	8 (11%)
Not currently homeless, but have been in the past three months	31 (79.50%)	25 (73.50%)	56 (76.75%)
Have not been homeless in the past 3 months	3 (7.70%)	6 (17.65%)	9 (12.30%)
Year of last HIV test			
1998-2007	1 (2.50%)	4 (11.75%)	5 (6.85%)
2009-2011	3 (7.70%)	7 (20.60%)	10 (13.70%)
2012-2014	35 (89.80%)	23 (67.65%)	58 (79.45%)
Unprotected anal or vaginal sex (no condom) with more than 3 men in the past 5 years			
Yes	29 (74.35%)	31 (91.20%)	60 (82.20%)
No	10 (25.65%)	3 (8.80%)	13 (17.80%)
Protected anal or vaginal sex (with condom) with more than 6 men in the past 5 years			
Yes	29 (74.35%)	20 (58.80%)	49 (67%)
No	10 (25.65%)	14 (41.20%)	24 (33%)
Previous STI in past 5 years			
Yes	10 (25.65%)	25 (75.50%)	35 (48%)
No	25 (74.35%)	9 (26.50%)	398 (52%)
Traded sex for drugs, money, or shelter in the past 5 years			
Yes	17 (43.60%)	21 (61.75%)	38 (52%)
No	22 (56.40%)	13 (38.25%)	35 (47%)
Slept with an HIV-positive man in the past 5 years (n=5, missing)			
Yes	1 (2.70%)	3 (9.70%)	4 (6%)
No	36 (97.30%)	28 (90.30%)	64 (94%)
Engaged in sex with a man who participated in at least one high risk behavior* **			
Yes	27 (69%)	31 (91%)	58 (79.50%)
No	12 (31%)	3 (9%)	15 (20.50%)

* All variables were caterogized and a chi-square test with a significance level of <0.05 was performed
**No associations were found significant
***High risk behaviors include: drug use, unprotected sex, sex with multiple partners, sex with other men, transactional sex, and sex with a known HIV positive partner
† (n=2, missing)
†† Married (n=3) and in a relationship (n=31)
‡ Data Collection Period: March 2014- November 2014

Table 3: Prevelance of HIV/AIDS Characterisitcs by County per 100,000 population*‡

Characteristics	Clayton**	Cobb**	Dekalb**	Fulton**	Gwinnett**	Estimated Overall †**
Sex*						
Male	1,115	458	1,832	2,121	297	1,847
Female	363	156	409	474	98	311
Race*						
White	447	139	771	638	131	376
Black	902	767	1,416	2,112	454	1,352
Hispanic	295	259	625	717	144	362
Age*						
13-24 ††	253	64	284	268	35	121
25-34	839	336	964	1,004	191	678
35-44	1,073	535	1,721	1,745	322	1,084
45-54	1,165	476	2,092	2,269	322	1,282
55+	401	149	626	968	117	498
Percent Uninsured (%)	27.3	19.8	25.8	22.9	24.5	-
Percent Living in Poverty (%)	22.6	14	19.4	17.7	13.6	-
Percent Completed High School Education (%)	82.6	90.2	87.9	89.6	87.3	-

*AIDSVu. Emory University, Rollins School of Public Health. Atlanta, GA. March 01, 2015 . www.aidsvu.org.

**n=No. of HIV/AIDs Cases per county as follows: Clayton (n=1,466), Cobb (n=1,692), DeKalb (n=6,171), Fulton (n=9,703), Gwinnett (n=1,247), and overall (n=20,279)

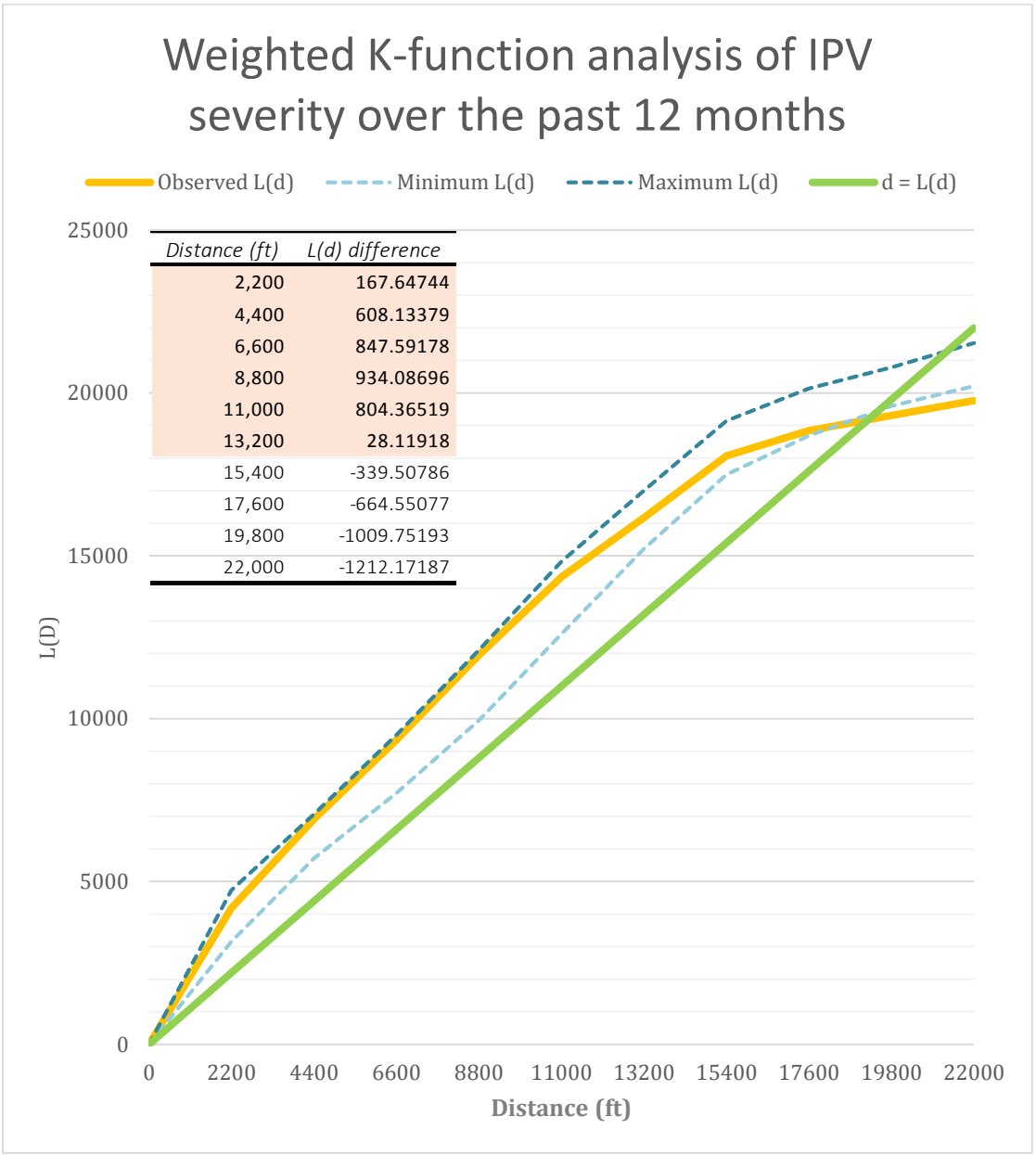
† Estimated overall prevelance for Clayton, Cobb, Dekalb, Fulton, and Gwinnett counties. All estimates were calculated using population estimates from the Online Analytical Statistical Information System (OASIS).

†† Calculated estimates used OASIS data for 15-24 year olds

‡Online Analytical Statistical Information System (OASIS). Georgia Department of Public Health, Officae of Health Indicators for Planning (OHIP). Atlanta, GA. March 11, 2015. www.oasis.state.ga.us/oasis/oasis/qryPopulation.aspx

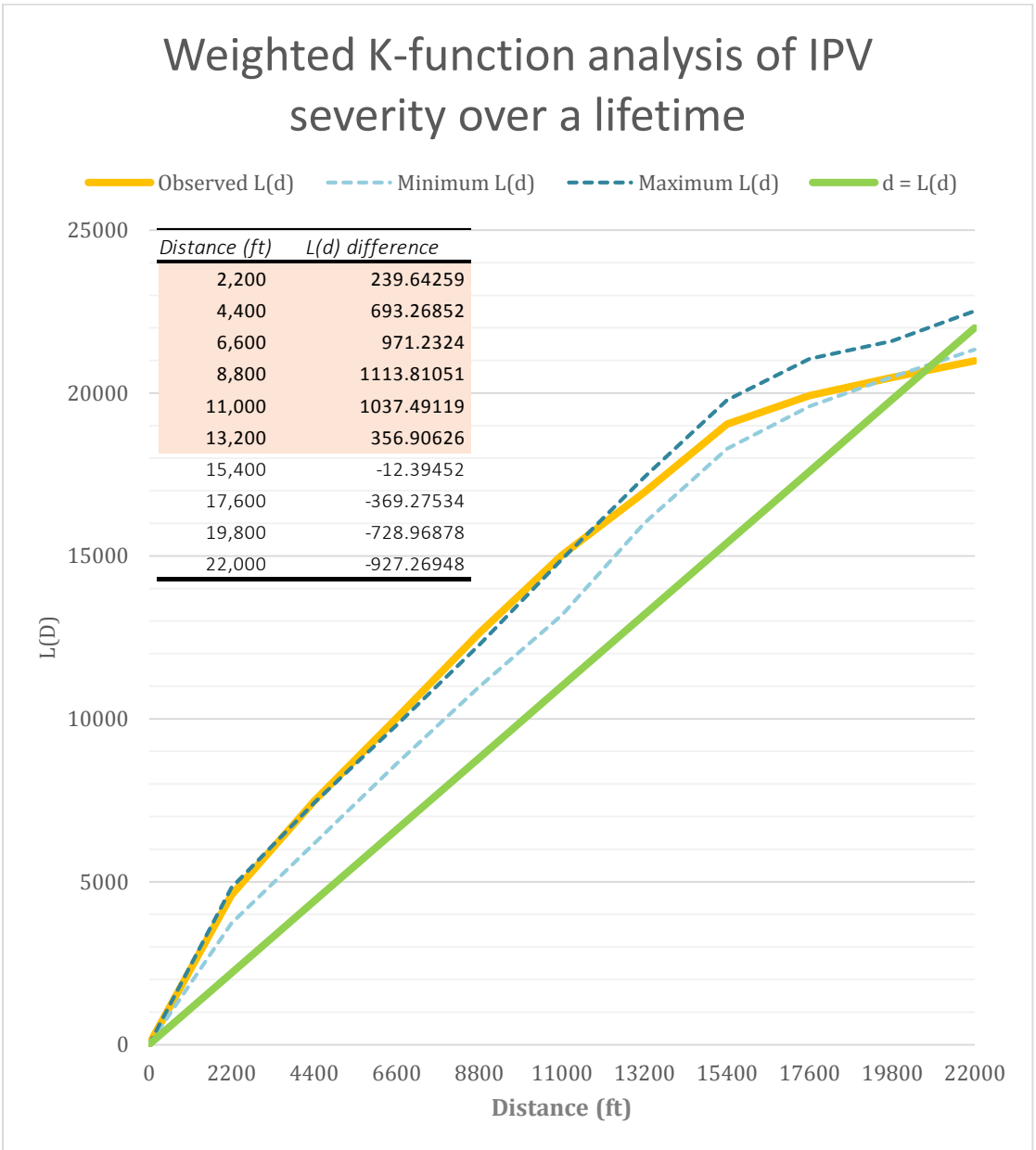
Appendix B: Graphs

Graph 1. ***Weighted k-function analysis of IPV severity over the past 12 months in metro-core Atlanta.***
The following graph is a Ripley's weighted k-function analysis of IPV severity over the past 12 months. The dotted lines represent minimum and maximum intervals (L(d)) where random distribution can occur. If the observed value is above the maximum, then it indicates that clustering occurs within certain observed distances. If the observed value is lower than the minimum L(d), within those observed distances. This graph indicates that there is not a global trend of clustering of this particular measure, but does not test for any local clustering measure. The chart within the graph represents the difference in L(d) values from the weighted k-function analysis minus the Ripley's k-function analysis. The highlighted cells represent the distances at which the outcome of global clustering was not influenced by spatial location



Distance (ft)	L(d) difference
2,200	167.64744
4,400	608.13379
6,600	847.59178
8,800	934.08696
11,000	804.36519
13,200	28.11918
15,400	-339.50786
17,600	-664.55077
19,800	-1009.75193
22,000	-1212.17187

Graph 2. ***Weighted k-function analysis of IPV severity over a lifetime in metro-core Atlanta.*** *The following graph is a Ripley's weighted k-function analysis of IPV severity a lifetime. The dotted lines represent minimum and maximum intervals (L(d)) where random distribution can occur. If the observed value is above the maximum, then it indicates that clustering occurs within certain observed distances. If the observed value is lower than the minimum L(d), then the points are evenly distributed within those observed distances. The results of this graph indicate that the points of clustering occur between 4,400ft and 11,000ft. Before and after those specified distances, we see random distribution of the points. This graph indicates that there is a small global trend of clustering of this particular measure. The chart within the graph represents the difference in L(d) values from the weighted k-function analysis minus the Ripley's k-function analysis. The highlight cells represent the distances at which the outcome of global clustering was not influenced by spatial location*



Distance (ft)	*L(d) difference*
2,200	239.64259
4,400	693.26852
6,600	971.2324
8,800	1113.81051
11,000	1037.49119
13,200	356.90626
15,400	-12.39452
17,600	-369.27534
19,800	-728.96878
22,000	-927.26948

Appendix C: Maps

Figure 1. ***Metro-core Atlanta with zip code tabulation area (ZCTA) and county boundary lines.***

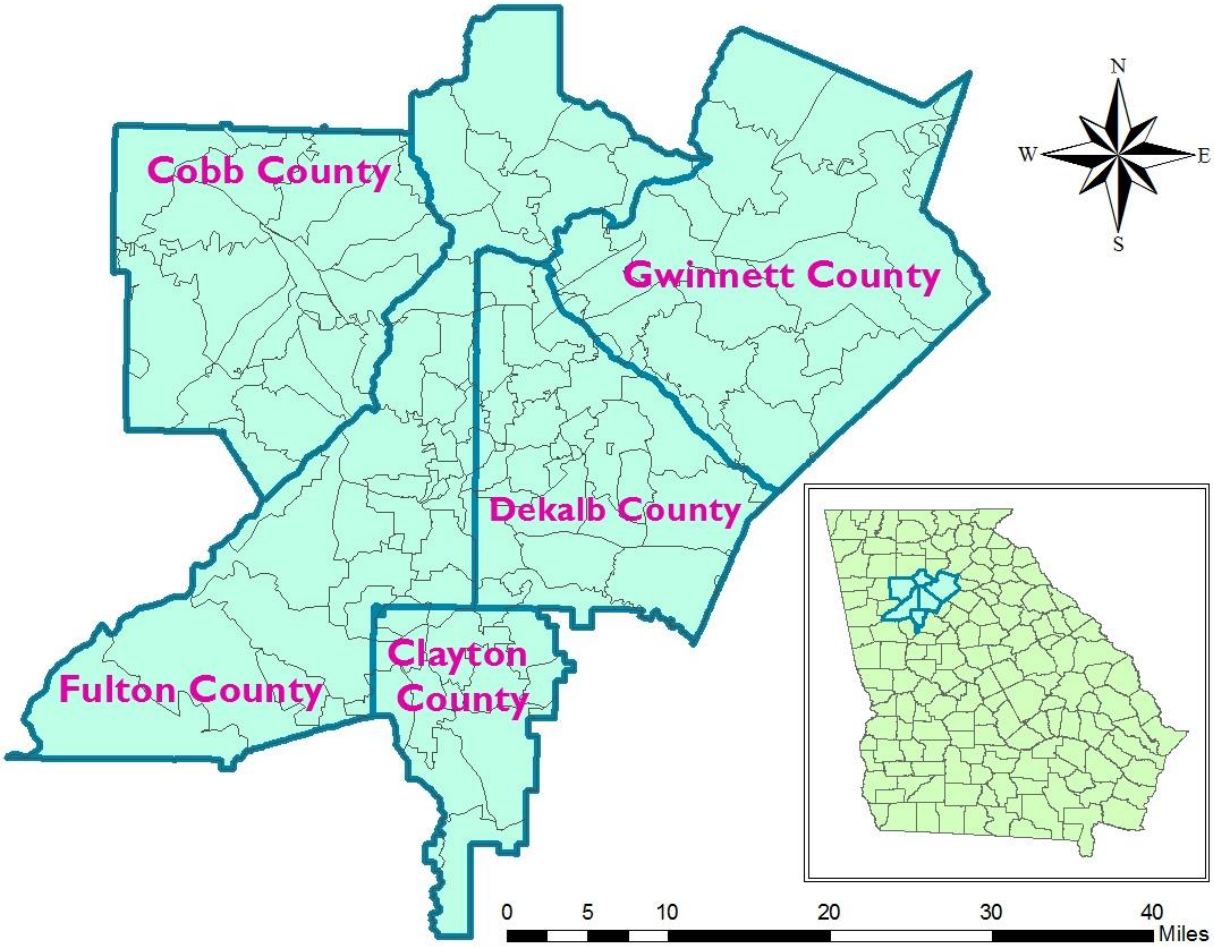


Figure 2. ***Geospatial Visualization of IPV severity levels in metro-core Atlanta.*** *Both maps display high and low IPV severity categories over the past 12 months and lifetime measures.*

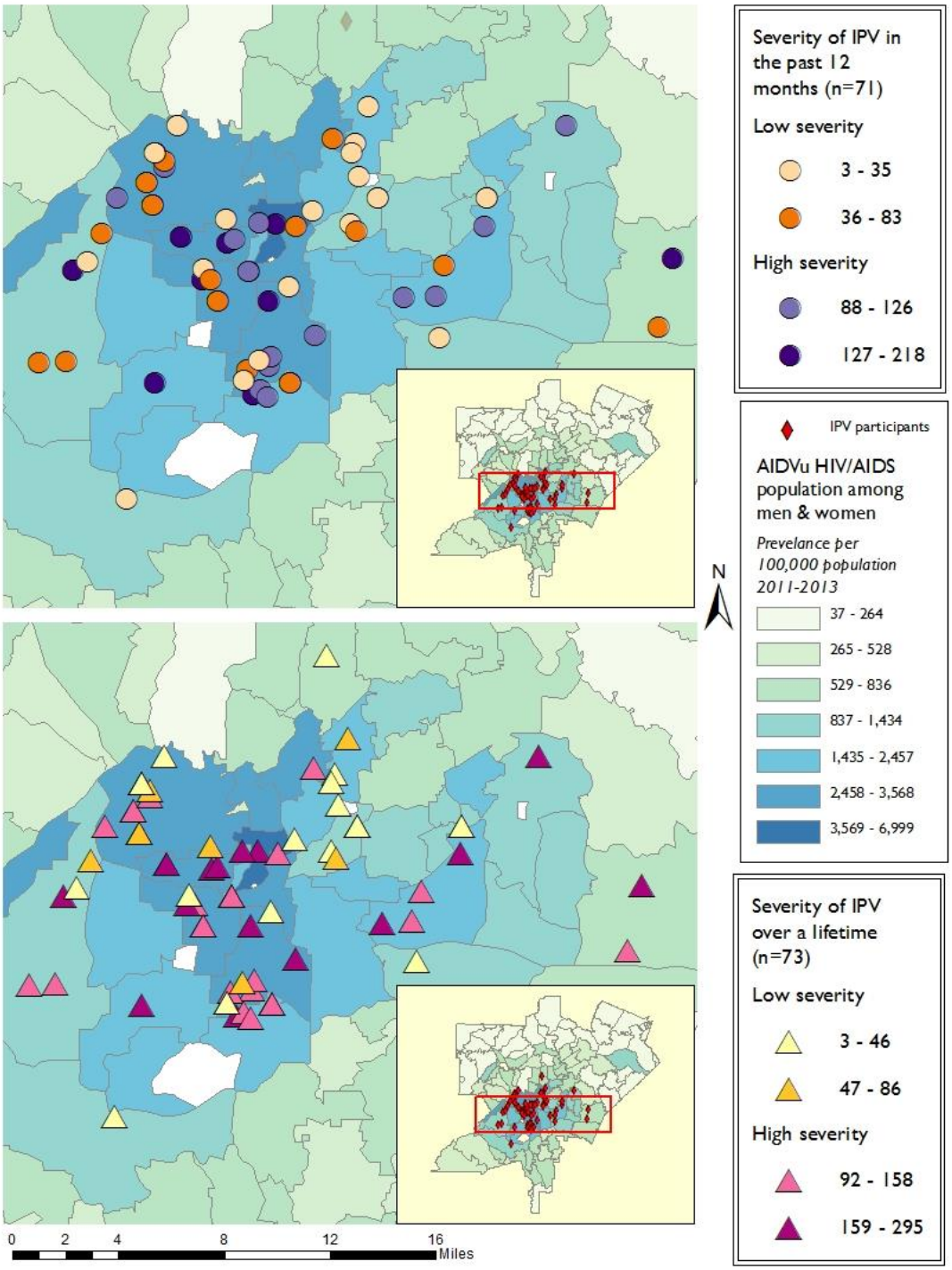


Figure 3. ***Kernel density map of IPV participants in metro-core Atlanta.*** *The map illustrates where participants reside, indicating the densest zip codes are 30307, 30310, 30314, 30315, 30318, 30354. Although this map does not provide any insight in IPV prevalence, it does show how this tool can be used to isolate regions, and visualize spread.*

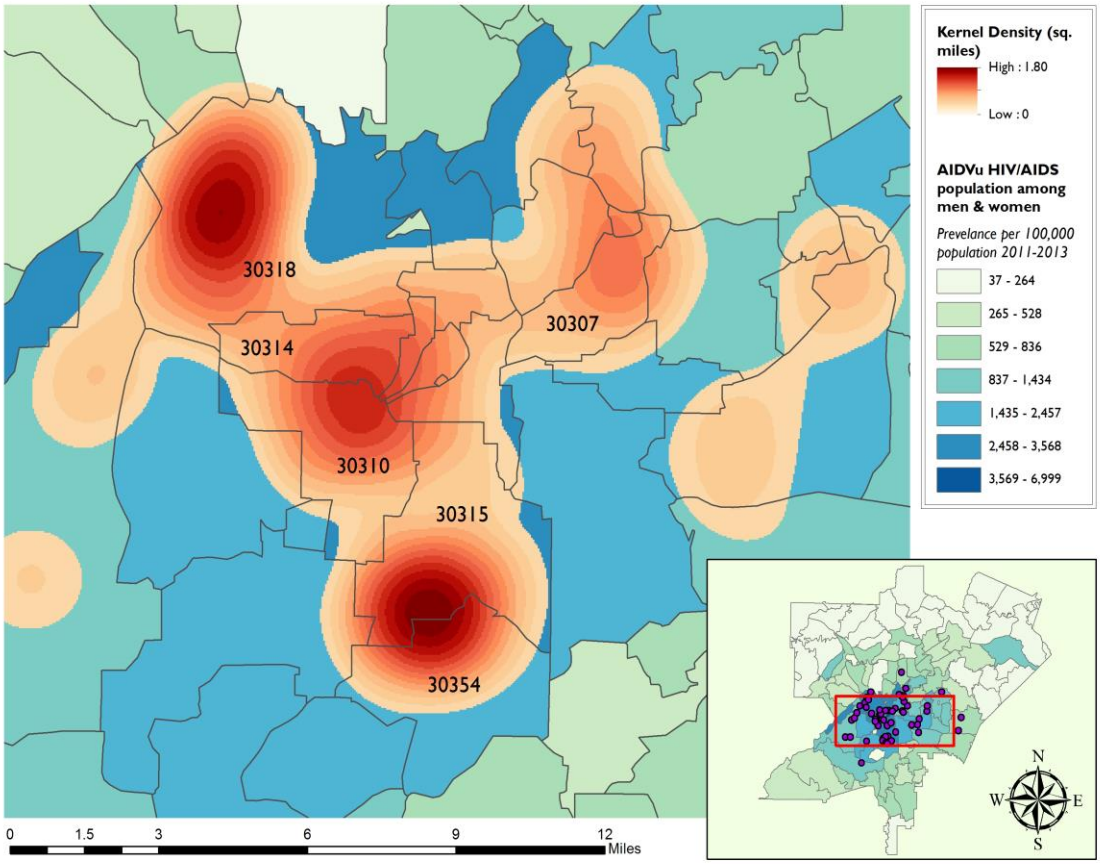


Figure 4. ***Getis-Ord G* (Hot spot) analysis of IPV severity over the past 12 months and lifetime measures in metro-core Atlanta***. *Variables were analyzed over a distance of 20,000ft (z-score = 3.17, α=0.05). The top map shows 2 hot spots that indicate high IPV severity and 4 cold spots that denote low IPV severity. The bottom map shows the same 2 hot spots that indicate high IPV severity and 5 cold spots that denote low IPV severity.*

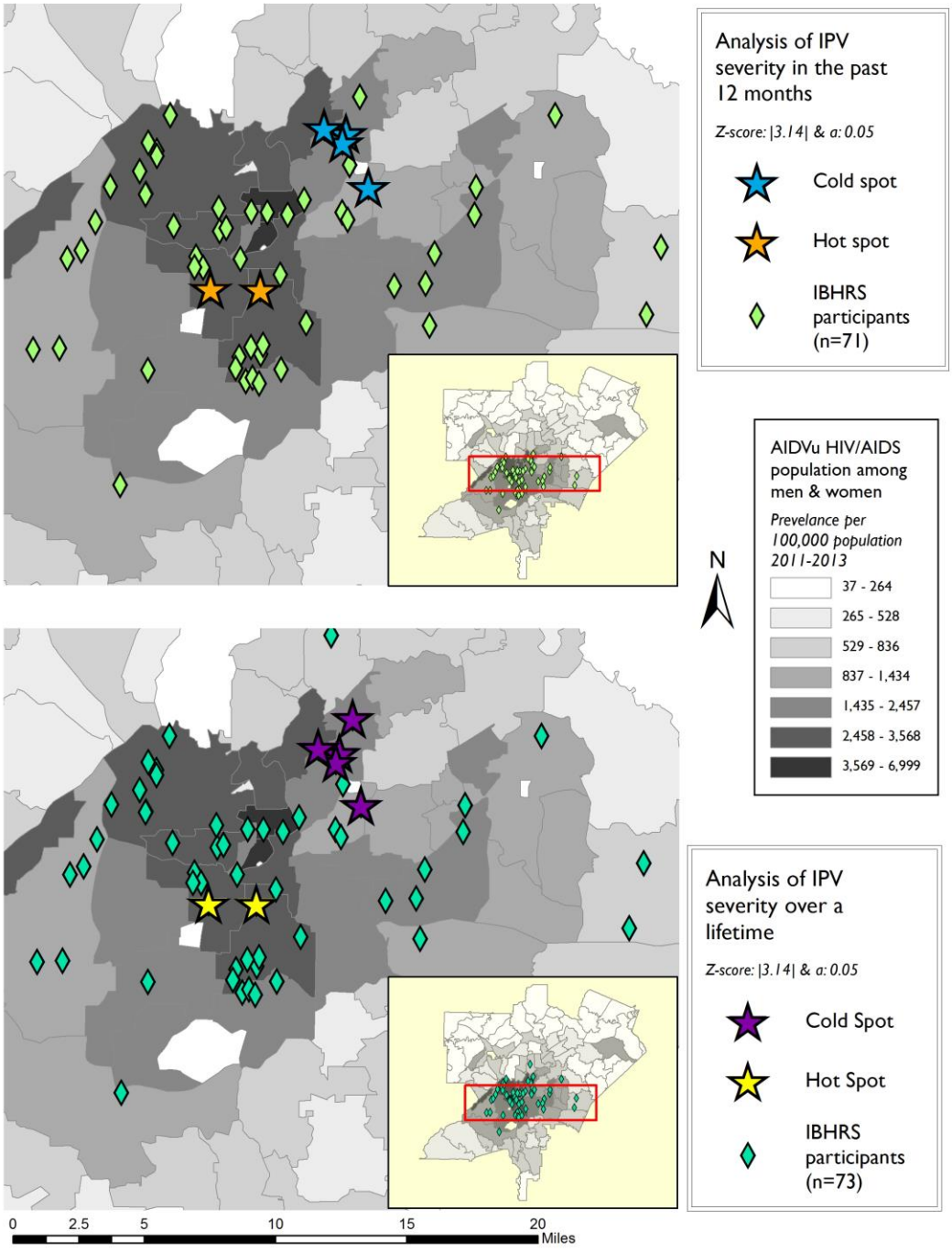


Figure 5. ***Kulldroff spatial scan of IPV severity over the past 12 months and lifetime measures in metro-core Atlanta.*** *The maps shows low and high clustering areas of IPV severity. Both maps were not scanned within a certain distance. An ordinal model was used for the spatial scan (p-value=0.04, α=0.05).*

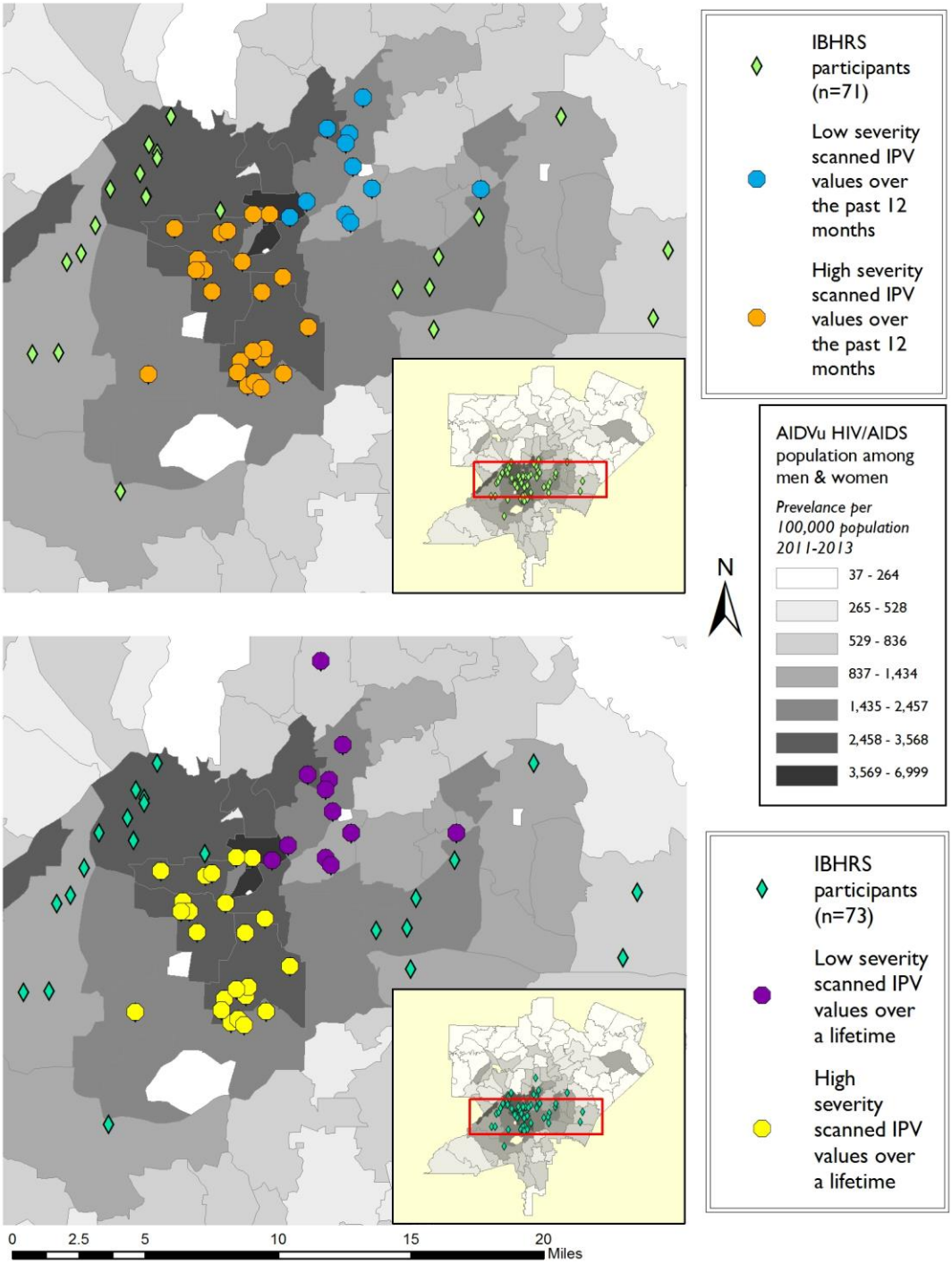
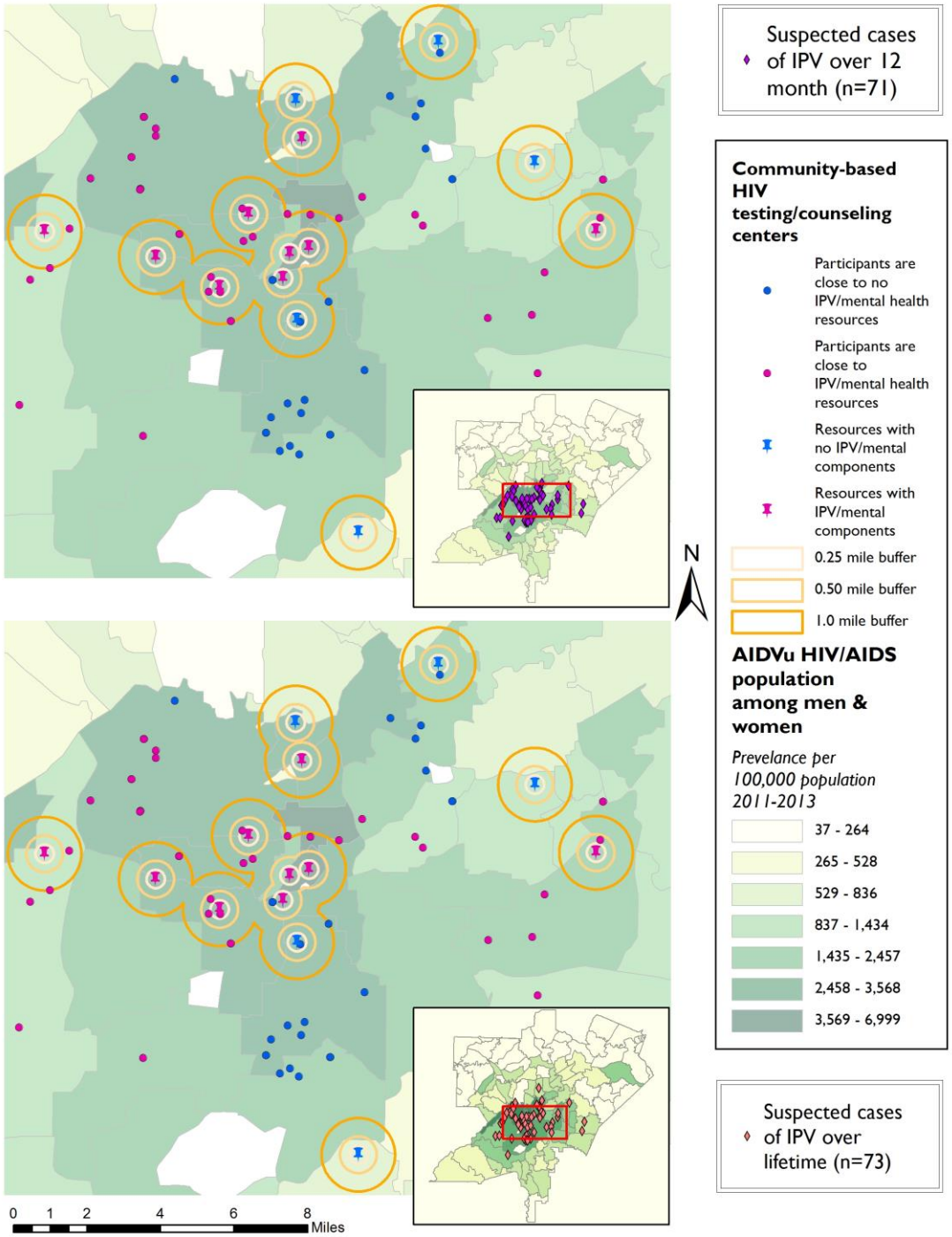


Figure 6. ***Resource buffer analysis of community-based HIV/AIDS testing/counseling centers in metro-core Atlanta.*** *This maps gives an overview of the two types of identified HIV/AIDS resources – with and without IPV/mental health services. Many of the participants are outside the 1 mile buffer area, however further research needs to be done to understand accessibility through a network analysis of public and private transportation.*



Chapter 4: Implications and Recommendations

Introduction

Intimate partner violence is a global issue that affects many women and men around the world, and is linked to increased risk of acquiring HIV. This study is among the first to examine how spatial tools can be useful in understanding the geographic intersections of IPV and HIV. Additionally, it goes further to briefly examine the distribution of community-based HIV and IPV integrative support services in relation to HIV and IPV high-prevalence areas.

Discussion and Limitations

Although the results of the study are not generalizable to a broader population, the study effectively showed that geospatial mapping is an important tool in better understanding the IPV and HIV syndemic in Atlanta and identifying geographic gaps in integrative support services. The results of the analysis identified areas of high HIV/AIDS prevalence (i.e. in Fulton and DeKalb counties of metro-core Atlanta) overlapped with the high severity IPV clusters. Additionally, all of the identified community-based HIV resources that incorporated IPV and mental health resources were located in high HIV/ADIS prevalence areas. However, there are still many individuals who live outside the 1-mile analysis buffer.

Study limitations included: 1) IPV data was obtained from a cross-sectional study that utilized a convenience sample of HIV high-risk women limiting our capacity to draw casual conclusion and generalize findings, 2) errors exist in the HIV prevalence rates calculated by county because of inherent overlap of ZCTA lines over county boundaries,

and 3) lastly, due to the type of data used, and the small sample size, many of the spatial analyses lost some power. Despite these limitations, the study is more of a testament that these tools have great potential utility in evaluating the IPV and HIV syndemic in more detail.

Implications and recommendations

Overall, the study was able to demonstrate the usefulness of spatial tools to heighten understanding of a nontraditional subject in relation to space. Moreover, recommendations and future directions should include:

1. *Research in the IPV and HIV syndemic through a geospatial lens should be focused on clustering IPV prevalence rates and performing a network analysis on accessibility of resources through private and public transportation means*

   In order to fully understand and compare these two issues, it would be ideal to have data that provided prevalence rates of women who are survivors of IPV, and their severity levels to make comparisons and draw relationships to high-risk HIV areas. Additionally, a comprehensive list of HIV testing and counseling resources should be complied to explore the current level of integrative resources; also a thorough network analysis on accessibility to these specific resources in general and based on IPV severity level can provide evidence to need and allocation of services.

2. *Continuing to raise awareness of intimate partner violence through education and advocacy*

   Many non-governmental, federal, state, local, and community organizations have been a part of violence education and advocacy. Partners like the National Sexual

Violence Resource Center (NSVRC), National Coalition Against Domestic Violence (NCADV), Safe Horizons, and many more, have contributed significantly to making the issue known. These organizations are a gateway to introducing the information gained from spatial analysis to better focus campaigns, outreach attempts, and education throughout the in high IPV severity clusters, and high HIV prevalence areas to address both issues.

3. *Influencing policies surrounding IPV preventative measures and treatment*

In 1994, President William J. Clinton passed the Violence Against Women Act (VAWA), which was reauthorized by President George W. Bush in 2006, and again in 2013 under President Barack H. Obama II. The act provided $US 1.6 billion to the investigations and prosecutions of violent crimes against women [57]. Additionally, the act provided funding to a variety of programs related to domestic violence managed by the Office of Violence Against Women (OVAW), and the Department of Justice (DOJ). Furthermore, the Affordable Care Act (ACA) has made women's health a priority by expanding preventative services. This includes not only covered HIV testing and counseling, but also violence screenings [41, 58]. Therefore, the results gained from these types of analysis will better be able to advocate for allocation of resources, and exemplify the benefits to incorporating IPV screenings at HIV centers. Additionally, the information can be used as a platform to continue to influence policies at state and local levels.

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