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Characteristics of the Residential Neighborhood Environment Differentiate Intimate Partner Femicide in Urban Versus Rural Settings

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Abstract

Purpose: A growing body of work examines the association between neighborhood environment and intimate partner violence (IPV). As in the larger literature examining the influence of place context on health, rural settings are understudied and urban and rural residential environments are rarely compared. In addition, despite increased attention to the linkages between neighborhood environment and IPV, few studies have examined the influence of neighborhood context on intimate partner femicide (IPF). In this paper, we examine the role for neighborhood-level factors in differentiating urban and rural IPFs in Wisconsin, USA.

Methods: We use a combination of Wisconsin Violent Death Reporting System (WVDRS) data and Wisconsin Coalition Against Domestic Violence (WCADV) reports from 2004 to 2008, in concert with neighborhood-level information from the US Census Bureau and US Department of Agriculture, to compare urban and rural IPFs.

Findings: Rates of IPF vary based on degree of rurality, and bivariate analyses show differences between urban and rural victims in race/ethnicity, marital status, country of birth, and neighborhood characteristics. After controlling for individual characteristics, the nature of the residential neighborhood environment significantly differentiates urban and rural IPFs.

Conclusions: Our findings suggest a different role for neighborhood context in affecting intimate violence risk in rural settings, and that different measures may be needed to capture the qualities of rural environments that affect intimate violence risk. Our findings reinforce the argument that multilevel strategies are required to understand and reduce the burden of intimate violence, and that interventions may need to be crafted for specific geographical contexts.

Key words epidemiology, geography, intimate partner violence, rural, social determinants of health.

Intimate partner violence (IPV) against women is a significant global public health problem,[1-4] affecting women across the lifespan and increasing risk for a number of adverse health outcomes, including chronic pain,[5] depression,[6] and adverse birth outcomes.[7] IPV has been defined as "threatened, attempted or completed physical or sexual violence, as well as the infliction of emotional abuse in the context of physical or sexual violence, and includes violence by a spouse, ex-spouse, current or former boyfriend or girlfriend, dating partner, or date."[8] Risk

factors for IPV include younger age,[9] shorter relationship duration,[10] marital status as unmarried or cohabiting,[10,11] alcohol use,[12] and lower socioeconomic status.[10] Violence rates vary among racial and ethnic groups,[11,13] and by geography.[14-16] In North America, where this study is based, the mean lifetime prevalence of domestic violence (DV) against women is estimated at 33% physical, 18% sexual, and 30% emotional violence.[16]

An extreme form of IPV is intimate partner femicide (IPF)—the murder of a woman by her intimate partner. In the United States, an estimated 30%–50% of murdered women are killed by a current or former intimate partner.[17,18] Risk factors for IPF include race, socioeconomic status, and foreign country of birth,[19,20] and IPF is often preceded by a history of IPV.[19] Risk factors for IPF include abuser unemployment, abuser access to a firearm, having lived with the abuser, having a child by a previous partner in the home with the abuser, previous threats by the abuser, and the combination of the abuser's controlling behavior and the woman's leaving or attempting to leave the relationship.[19]

Most IPV research has focused on individual risk factors. Recently, more attention has been paid to geographical setting. In 1995, O'Campo et al found a significant neighborhood effect for neighborhood unemployment and per capita income on risk of violence during pregnancy for women in an urban area, while controlling for individual-level variables.[9] Miles-Doan followed with 2 spatial analyses of police records in Duval County, Florida (including Jacksonville), finding associations between neighborhood deprivation and IPV rates.[21,22] Other researchers have continued this line of inquiry, expanding the range of variables considered, exploring additional study areas, deepening the complexity of analysis, and expanding the range of study findings, although studies have focused on urban populations and nationally representative survey samples.[10,12,17,23,24]

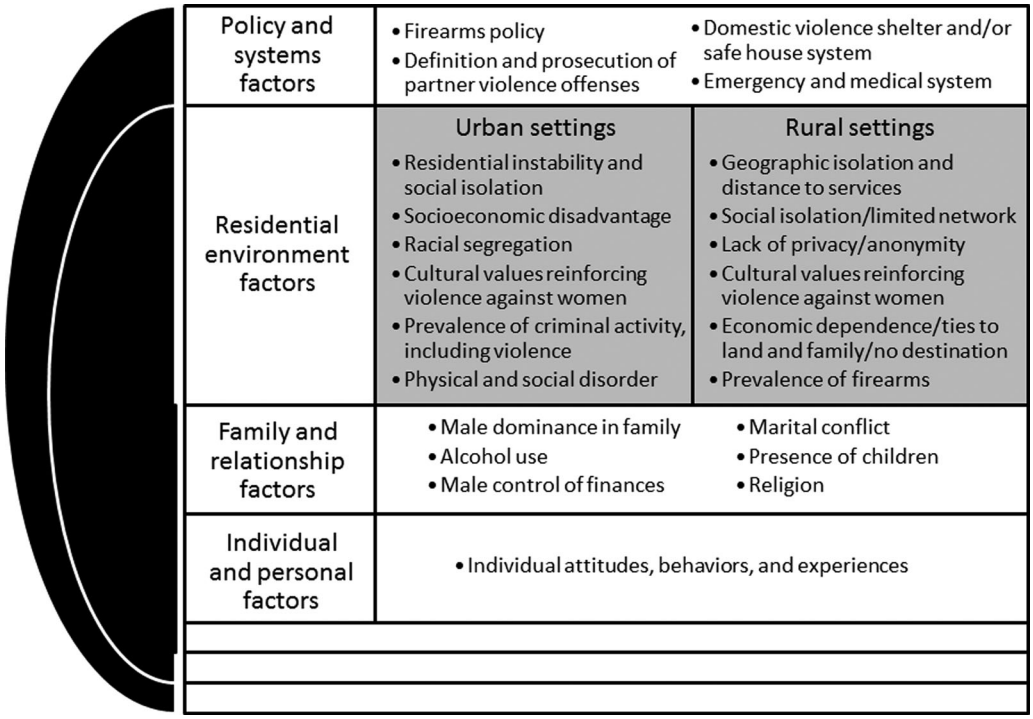
Most studies have drawn primarily from social disorganization theory to frame research questions. This theory describes how socioeconomic disadvantage and residential instability disrupt social bonds and limit collective ability to maintain social control, increasing the likelihood of deviant behaviors such as violence.[25-27] Results of studying the relationship between neighborhood disadvantage and individual risk of IPV have been mixed. Several researchers report significant associations,[9,17,28] others report nonsignificant effects,[12] and still others report differential effects based on race/ethnicity,[13] or confounding effects between race and neighborhood-level disadvantage.[10,17] Residential stability, traditionally hypothesized to have a stabilizing effect in neighborhoods that could reduce violent crime rates, has been found instead to be associated with increased IPV risk,[12,28] or to have no association,[23] leading researchers to question the meaning of residential instability in an age when it may be associated with higher levels of education and mobility. Some have suggested that residential stability could actually prolong and deepen one's experience of disadvantage.[12]

Recent work explores the relationship between neighborhood conditions and IPV in non-Western and developing country settings, with more focus on social norms and values. Two studies analyzed the Indian National Family Health Survey, finding a significant effect for a state-level measure of gender equality[29] and a gradient effect related to community-level literacy rates.[29] A third study found significant effects for community wife beating norms and community violence.[30] One study found an association between measures of violence in a woman's immediate geographic environment and risk of individual sexual and physical victimization in Colombia.[31] Another found that sociocultural context affects the influence of community characteristics on risk, finding significant associations between women's lack of autonomy and risk of violence only in the less culturally conservative of 2 study regions.[32] One study also examined the relationship among neighborhood and state-level socioeconomic status with attitudes toward IPV against women in several African countries.[33]

Despite the growing body of work examining geographical setting and IPV, rural settings are understudied. Madkour et al noted that the question of "how concentrated disadvantage is related to intimate partner homicide in nonurban counties has not yet been explored."[34] There is reason to believe that characteristics of the residential environment are linked to IPV in rural settings, and that the nature of urban and rural geographical settings may affect risk in different ways. The literature reveals a number of place-related contextual factors that have been linked to a woman's IPV risk, or ability to leave an abusive situation, in rural settings.

Factors identified to be important in rural areas include: geographic isolation (eg, distance from neighbors, police, medical facilities), cultural factors (eg, patriarchal values, religious values emphasizing the marital bond), lack of anonymity/privacy/confidentiality (eg, police, doctors, judges have personal relationships with victim or perpetrator, locations of shelters and safe houses are common knowledge), social isolation (eg, few friends and acquaintances, especially outside of the immediate community), resource/service access (eg, low population density is associated with low resource density), legal system constraints (eg, lack of legal aid, limited enforcement of restraining orders), economic dependence (eg, farm women's income is tied to their place of residence), and firearms (eg, more available or accepted, or subject to fewer controls).[15,35-44]

Figure 1 Conceptual Model Relating Individual, Social and Ecological Factors to Intimate Partner Violence in Urban and Rural Areas.



Many have hypothesized that IPV differs in urban and rural settings, but few have documented the differences empirically. We seek to understand how IPF victims and circumstances surrounding their deaths differ in urban versus rural settings, with a specific interest in the residential environmental characteristics experienced by IPF victims. Our work is guided by the conceptual model shown in Figure 1, and it is informed by the social-ecological model of disease proposed by Heise[2] relating both social and geographical characteristics to violence against women. Our model specifies possible differences in residential environmental factors that may be associated with IPV in urban versus rural areas. In this paper, we (1) describe characteristics of IPFs in Wisconsin using a unique combination of 2 datasets to avoid misclassification bias, and (2) determine whether and how levels of neighborhood disadvantage and instability—constructs often studied when relating neighborhood setting to IPV—differ among urban and rural IPFs.

Methods

Data Sources

We analyzed data from the Wisconsin Violent Death Reporting System (WVDRS) for 2004–2008. WVDRS is part of the National Violent Death Reporting System (NVDRS), which is a population-based active surveillance system that links multiple data sources to provide a census of violent deaths that occur within the borders of participating US states.[45] No sampling is employed; all violent deaths are included. Violent deaths are defined, based on the World Health Organization's definition, as deaths resulting from "the intentional use of physical force or power against oneself, another person, or against a group or community."[45] An abstractor at the Wisconsin Department of Health Services generates WVDRS records based on the "manner of death" listed on Wisconsin death certificates.

WVDRS has 2 key limitations. First, IPFs are difficult to identify. Although WVDRS contains codes indicating whether or not a death was "IPV" or "jealousy" related, it does not specify whether the perpetrator was the woman's intimate partner. Other data sources, including the Supplemental Homicide Reports (SHR), have also been subject to misclassification bias on this subject.[18] Second, WVDRS records reflect knowledge of the violent death fairly soon after it has occurred and are based on official records, and thus do not include extensive information on the perpetrator or circumstances of the deaths. To accurately identify IPFs within WVDRS and to gain a more complete picture of the circumstances, we consulted an additional data source.

The Wisconsin Coalition Against Domestic Violence (WCADV) publishes an annual report on DV homicides, drawing from publicly available information, such as news reports and court records, to provide details of each homicide, with the goal "to construct as accurate a description as possible of key events and circumstances related to each homicide."[46] Reports contain narratives for each death. We used these reports, in addition to files maintained by WCADV for each woman, to validate each death as an IPF and document other circumstances of the homicide not contained in WVDRS, including the woman's relationship with the perpetrator and prior IPV history.

We began with a dataset including all homicides of females age 16 or older within Wisconsin from 2004 to 2008 (n = 216). We then compared WVDRS records with WCADV reports and files and determined 87 deaths to be IPFs. Because we are interested in the role that neighborhood plays in differentiating urban and rural IPFs, we limited our dataset only to Wisconsin residents for whom the geographic location of the residence could be determined. Our final dataset included 84 IPFs. In addition, we analyzed US Census 2000 data by census tract to examine urban-rural differences in population demographics to provide a comparison point for our findings.

Urban Versus Rural Designation

Neighborhood was defined as the US Census Tract. We geocoded residential addresses for all femicide victims and linked these point locations to the tract within which they fell. An initial automated run geocoded most of the records; a small number were matched manually, addressing spelling errors, and examining possible alternative city or postal (ZIP) code assignments. In matching records, uncertainty in precise location was considered acceptable if it did not change the neighborhood to which the record would be assigned. We were able to assign all 84 IPFs to neighborhoods.

Census tract Rural-Urban Commuting Area (RUCA) codes were used to determine victim residence in a rural versus urban area.[47,48] RUCA codes use "the standard Bureau of Census Urbanized Area and Urban Cluster definitions in combination with work commuting information to characterize all of the nation's census tracts regarding their rural and urban status and relationships."[47] Due to the limited sample size, we define "urban" as the "metro" category (n = 60, RUCA codes 1–3) and "rural" as the combination of the "micro," "small town" and "rural" designations (n = 24, RUCA codes 4–10). Figure 2 includes 2 maps of our study area with RUCA categories and our definitions of urban and rural areas represented.

Measures

At the victim level, we explored the victim's age, race/ethnicity (white, black, other), marital status (never married, married, divorced/widowed), education level (less than high school, high school degree, some college or higher), country of birth (USA or foreign born), and whether she was known to be pregnant at the time of or within a year prior to death.

At the level of the perpetrator and relationship, we examined perpetrator age, relationship (husband, boyfriend, ex-husband/boyfriend), condition of relationship (intact or in some stage of dissolution), the presence of young children in the household or family, and indications of an IPV history, such as restraining orders or reports of the woman leaving the relationship due to violence. If no mention was made of trouble in the relationship, it was considered to be "intact." In categorizing relationship with the perpetrator, a fiancé was categorized as a boyfriend and a longtime partner was categorized as a husband.

Homicide characteristics studied include weapon type causing the fatal injury (firearm, sharp/knife, other), number of penetrating wounds (wounds made by a gun or knife), victim alcohol use prior to the homicide, whether the homicide occurred in the home, and the status of perpetrator after homicide (alive, committed suicide, other; eg, contemplated or attempted suicide or died from a nonsuicide event).

At the neighborhood level, we explored 2 measures—an index of concentrated disadvantage, and a measure of residential instability. We developed a Concentrated Disadvantage Index, as employed previously.[12] Following previous researchers,[12] and to focus on constructs embedded within Social Disorganization Theory, we determined that our index would include the following variables from the 2000 US Census: proportion of the population on public assistance, proportion below the poverty line, proportion single-parent households, and proportion unemployed. We then used a Principal Components Analysis to identify variable loadings within the first component; these loadings were used as weights, multiplied by the z score of each census tract's variable value, to form our index. We also measured residential instability as the proportion of individuals living in a different house than they had 5 years before, based on US Census 2000 estimates.

Statistical Analysis

We undertook descriptive analyses of all IPFs (n = 84). We calculated rates of IPF by degree of rurality and then compared the characteristics of urban and rural IPF

Figure 2 Rural-Urban Commuting Areas in Wisconsin by US Census Tract, 2000.

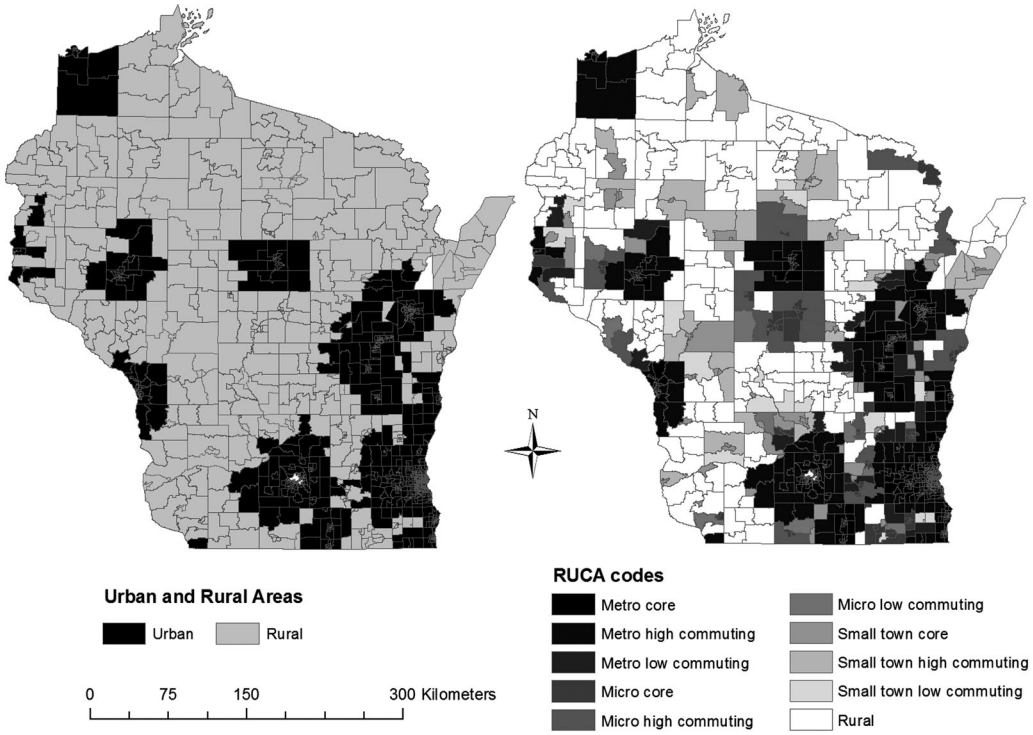


Table 1 Comparison of Marital Status and Relationship to Perpetrator Among Intimate Partner Femicides in Wisconsin, 2004-2008

	Relationship to Perpetrator (n, row%, column%)		
Marital status	Boyfriend	Husband	Former husband or boyfriend
Never married	19 (70.37%, 65.52%)	1 (3.70%, 3.57%)	7 (25.93%, 25.93%)
Married	2 (5.26%, 6.90%)	24 (63.16%, 85.71%)	12 (31.58%, 44.44%)
Divorced/ widowed	8 (42.11%, 27.59%)	3 (15.79%, 10.71%)	8 (42.11%, 29.63%)

victims and circumstances surrounding the deaths using Fisher exact test, given our small sample size. We also made a direct comparison of marital status and relationship with the perpetrator to determine whether the 2 variables measured the same intimate partner relationship. Because clear differences emerged (see Table 1), we fit 2 sets of models based on each of these 2 constructs. Multivariable logistic regression analyses were performed to determine whether neighborhood-level characteristics were associated with rural residence, controlling for individual-level characteristics. We considered age, race, marital status, relationship with perpetrator, and level of education at the individual level, and concentrated disadvantage and residential instability at the neighborhood level. We first constructed an individual-level model, and then we proceeded to consider neighborhood context. Collinearity between disadvantage and instability revealed a correlation of $r = 0.49$. Separate analyses of neighborhood disadvantage and instability showed similar effect directions and sizes as models considering them simultaneously. Tertiles for concentrated disadvantage and residential instability were defined separately for rural and urban women. The Hosmer-Lemeshow goodness of fit test[49] indicated a satisfactory model fit. A statistical significance (alpha) level of .05 was specified. STATA/IC 11 (STATCorp, College Station, Texas, USA) was used to perform all statistical analyses and a combination of Esri ArcMap 10 (Esri, Redlands, California, USA) and Google Maps™ (Google Inc., Mountain View, California, USA) mapping service were used for geocoding and neighborhood assignment. This analysis underwent human subjects review.

US Census Data Analysis

To compare our findings to general patterns of demographic differences among Wisconsin's urban and rural areas, we conducted an analysis of US Census data by census tract. We calculated odds ratios to illustrate the

Table 2 Intimate Partner Femicide Rates by Degree of Rurality in Wisconsin, 2004-2008

RUCA category	IPFs	Woman-Years	Rates Per 1 Million Woman-Years
RUCA "metro"	60	7,295,495	8.22
RUCA "micro"	6	1,190,310	5.04
RUCA "small-town"	10	1,019,385	9.81
RUCA "rural"	8	1,124,790	7.11
RUCA micro-smalltown-rural combined	24	3,334,485	7.20
Total	84	10,629,980	7.90

Rates are calculated using Census 2000 estimates for women ages 16 or older by US Census Tract. Shaded rows indicate categories used in our comparison of urban and rural IPFs.

relationships between demographics of interest and rurality, using the same RUCA definitions employed in our analysis of WVDRS data to define urban and rural areas. Odds ratios relating age groups included women ages 16 and older, while analyses of race, marital status, educational attainment, disadvantage, and instability included women ages 18 and older, due to the data categories available from the US Census Bureau. To examine disadvantage and instability, tertiles were defined for all census tracts combined, whereas tertiles for these variables as entered into our models were defined for urban and rural women separately.

Results

Descriptive and Bivariate Analyses

Table 2 shows rates of IPF by degree of rurality. The highest rate was observed in the small town category, followed by the metropolitan, rural, and micropolitan categories. Table 3 shows characteristics of the IPF deaths and Table 4 shows results of bivariate analyses comparing urban and rural deaths. The median age of victims was 37, with a wide range from age 16 to 75. Similarly, the median age of perpetrators was 40, with a range from 18 to 79. Age was not significantly different between urban and rural women.

Race differed significantly between urban and rural women ($P = .003$), with no black women murdered in rural areas, and a lower proportion of women of "other" races or ethnicities murdered in rural areas than urban ones. Fully 83% of rural women murdered were white. In addition, all women murdered in rural areas were born in the United States, as opposed to 82% in urban areas ($P = .029$).

Nearly half of all victims were married and marital status was significantly different between urban and rural

Table 3 Characteristics of IPF Deaths in Wisconsin, USA, 2004-2008 (n = 84)

Victim Characteristics	N (%) or median [range]
Age (WVDRS,WCADV)	37 [16, 75]
Race (WVDRS)	
White	49 (58.33)
Black	16 (19.05)
Hispanic	6 (7.14)
Asian	6 (7.14)
Other or unspecified	7 (8.33)
Marital status (WVDRS)	
Never married	27 (32.14)
Married	38 (45.24)
Divorced	15 (17.86)
Widowed	4 (4.76)
Level of education (WVDRS)	
8th grade	5 (5.95)
Some high school	10 (11.90)
High school degree (or GED)	34 (40.48)
Some college	7 (8.33)
Associate's degree	12 (14.29)
Bachelor's degree	13 (15.48)
Master's degree	2 (2.38)
Unknown	1 (1.19)
Country of birth (WVDRS)	
USA	73 (86.90)
Foreign	7 (8.33)
Unknown	4 (4.76)
Pregnant within year of death (WVDRS)	
No	61 (72.62)
Yes	5 (5.95)
Within last year	2 (2.38)
Unknown	16 (19.05)
Perpetrator and Relationship Characteristics	**N (%) or median [range]**
Perpetrator age (WCADV)	40 [18,79]
Perpetrator relationship	
Husband	26 (30.95)
Estranged husband	11 (13.10)
Ex-husband	5 (5.95)
Boyfriend	28 (33.33)
Estranged boyfriend	1 (1.19)
Ex-boyfriend	10 (11.90)
Fiancé	1 (1.19)
Longtime partner	2 (2.38)
Relationship condition	
Intact	35 (41.67)
Unstable	9 (10.71)
Ending	21 (25.00)
Recently finished	4 (4.76)
Finished	15 (17.86)
Couple with young children (ages 0-18)	
Yes	42 (50.00)
No	15 (17.86)
Unknown	27 (32.14)

Continued

Table 3 Continued

History of IPV	
Yes	38 (45.24)
Possible	7 (8.33)
Unknown	39 (46.43)
Homicide Characteristics	**N (%) or median [range]**
Weapon type causing fatal injury (WVDRS)	
Beating (personal-fists, feet)	2 (2.38)
Beating (blunt object)	8 (9.52)
Burn	2 (2.38)
Suffocation/strangulation	7 (8.33)
Sharp object	21 (25.00)
Firearm	36 (42.86)
Poison	3 (3.57)
Unknown	5 (5.95)
Number of penetrating wounds (WVDRS)	
No wounds	23 (27.38)
One wound	15 (17.86)
Multiple wounds	28 (33.33)
Unknown	18 (21.43)
Suspected alcohol use by victim (WVDRS)	
No	52 (61.90)
Yes	17 (20.24)
Unknown	15 (17.86)
Homicide took place in the home (WVDRS)	
No	19 (22.62)
Yes	63 (75.00)
Unknown	2 (2.38)
Perpetrator status after homicide (WCADV)	
Alive	49 (58.33)
Alive, but contemplated suicide	1 (1.19)
Alive, but attempted suicide	3 (3.57)
Alive, but attempted suicide by cop	1 (1.19)
Committed suicide	27 (32.14)
Deceased (legal or family intervention)	3 (3.57)
Geographical Characteristics	**N (%) or median [range]**
Concentrated disadvantage index (urban)	–0.64 [–1.66, 9.75)
Concentrated disadvantage index (rural)	–0.52 [–1.45, 7.71]
Residential instability (urban)	0.44 [0.22, 0.96]
Residential instability (rural)	0.37 [0.24, 0.75]

areas ($P = .050$). Compared to their urban counterparts, the odds of women in rural areas being married compared to having never been married were 4 times greater (OR = 4.18, 95% CI = [1.09, 19.49]; $P = .028$).

Slightly over 40% of victims had a high school education. Level of education did not significantly differentiate urban and rural women. Pregnancy at time of death or within a year before death was not significantly different among urban and rural women and represented 6% of all women.

Type of relationship with the perpetrator was marginally significantly different (P value = .055), with a smaller proportion of women in rural areas murdered by a boyfriend, as compared to a husband. This mirrors the findings with regard to marital status, with a higher proportion of rural women married. Perpetrator age, condition of the relationship, presence of young children, and history of IPV were not significantly different between urban and rural deaths. In almost 60% of both urban and rural deaths, there were indications of trouble in the relationship, with 25% of deaths showing an indication that the relationship was moving toward dissolution at the time of death. In almost half of the deaths, the couple was known to have young children.

No homicide characteristics examined (weapon type, number of penetrating wounds, suspected alcohol use, whether homicide took place in the home, whether the perpetrator committed suicide) were significantly different for urban versus rural deaths. Firearms were the most common weapons causing the fatal injury (43%). Seventy-six percent of urban and 78% of rural deaths took place in the home. In 33% of urban and 29% of rural deaths, the perpetrator committed suicide.

Fully 71% of victims lived in urban areas. Residential instability differed among rural and urban women, with women living in neighborhoods with higher instability less likely to be rural than to be urban (high to low instability OR = .17, 95% CI = [0.03, 0.88]). Neighborhood disadvantage did not differ significantly between urban and rural women.

Multivariate Analyses

Results of our multivariate analyses are shown in Table 5. We began with the individual-level predictors age, race, marital status, and level of education. Race was dichotomized to white/other due to small numbers. Both race and marital status were significantly associated with rural setting, with non-white women less likely to be rural (OR = 0.15, 95% CI = [0.04, 0.57]), and married women more likely to be rural than never married women (OR = 7.04, 95% CI = [1.61, 30.88]). When controlling for neighborhood disadvantage, race and marital status remain significant. Neighborhood disadvantage is not significantly associated with rurality.

When adding neighborhood instability to our individual-level model, high instability is significantly associated with rurality, with women living in high instability neighborhoods less likely to be rural (high to low instability OR = 0.17, 95% CI = [0.03, 0.97]). With neighborhood disadvantage and instability examined simultaneously, the effects for race and instability increase in magnitude, with women living in neighborhoods with more residential instability much less likely to be rural

Table 4 Characteristics of Urban Versus Rural Intimate Partner Femicides

	Geographical Location			
Victim Characteristics	Urban (n = 60, 71%) (n, %)	Rural (n = 24, 29%) (n, %)	Unadjusted Odds Ratio (95% CI)	*P* Value
Victim's age (WVDRS, WCADV)				.306
16-24	13 (21.67)	5 (20.83)	Referent	
25-34	15 (26.67)	4 (16.67)	0.65 (0.11, 3.77)	
35-44	15 (25.00)	11 (45.83)	1.91 (0.45, 8.83)	
45+	16 (26.67)	4 (16.67)	0.65 (0.11, 3.77)	
Victim's race (WVDRS)				.003[a]
White	29 (48.33)	20 (83.33)	Referent	.001[a]
Black	16 (26.67)	0 (0.00)	0.00 (0.00,0.37)	.163
Other	15 (25.00)	4 (16.67)	0.39 (0.08, 1.48)	
Victim's marital status (WVDRS)				.050[a]
Never married	23 (38.33)	4 (16.67)	Referent	
Married	22 (36.67)	16 (66.67)	4.18 (1.09 19.49)	.028[a]
Divorced/widowed	15 (25.00)	4 (16.67)	1.53 (0.24, 9.54)	.700
Victim's level of education (WVDRS)				.304
Less than HS degree	13 (22.03)	2 (8.33)	Referent	
HS degree	22 (37.29)	12 (50.00)	0.28 (0.03, 1.63)	
Some college or higher	24 (40.68)	10 (41.67)	2.71 (0.46, 28.58)	
Victim's country of birth (WVDRS)				.029[a]
USA	49 (81.67)	24 (100.00)	Referent	
Foreign or unknown	11 (18.33)	0 (0.00)	0 (0.00, 0.74)	.029[a]
Pregnant within year of death (WVDRS)				.099
No or unknown	57 (95.00)	20 (83.33)	Referent	
Yes	3 (5.00)	4 (16.67)	3.8 (0.58, 27.71)	
Perpetrator and Relationship Characteristics	Urban (n = 60, 71%)	Rural (n = 24, 29%)	Unadjusted odds ratio	*P* value
	(n, %)	(n, %)	(95% CI)	
Perpetrator age (WCADV)				.985
16-24	8 (13.33)	4 (16.67)	Referent	
25-34	12 (20.00)	4 (16.67)	0.67 (0.09, 4.81)	
35-44	22 (36.67)	9 (37.50)	0.82 (0.16, 4.70)	
45+	18 (30.00)	7 (29.17)	0.78 (0.14, 4.73)	
Perpetrator relationship to victim (WCADV)				.055
Boyfriend	25 (41.67)	4 (16.67)	Referent	
Husband	16 (26.67)	12 (50.00)	4.69 (1.13, 22.88)	
Ex- or estranged husband or boyfriend	19 (31.67)	8 (33.33)	2.63 (0.59, 13.55)	
Relationship condition (WCADV)				1.000
Intact	25 (41.67)	10 (41.67)	Referent	
In trouble	35 (58.33)	14 (58.33)	1.00 (0.34, 2.89)	
Couple with young children ages 0-18 (WCADV)				.767
Yes	29 (48.33)	13 (54.17)	Referent	
No	12 (20.00)	3 (12.50)	0.56 (0.09, 2.61)	
Unknown	19 (31.67)	8 (33.33)	0.94 (0.28, 3.02)	
History of IPV (WCADV)				.378
Unknown	25 (41.67)	14 (58.33)	Referent	
Possible	5 (8.33)	2 (8.33)	1.40 (0.19, 16.41)	
Yes	30 (50.00)	8 (33.33)	0.48 (0. 15, 1.47)	
Homicide Characteristics	Urban (n = 60, 71%)	Rural (n = 24, 29%)	Unadjusted odds ratio	*P* value
	(n, %)	(n, %)	(95% CI)	
Weapon (WCADV)				.240
Shot	24 (40.00)	13 (54.17)	Referent	
Stabbed	21 (35.00)	4 (16.67)	0.35 (0.07, 1.40)	
Other	15 (25.00)	7 (29.17)	0.86 (0.23, 3.00)	

Continued

Table 4 Continued

Victim Characteristics	Geographical Location: Urban (n = 60, 71%) (n, %)	Geographical Location: Rural (n = 24, 29%) (n, %)	Unadjusted Odds Ratio (95% CI)	*P* Value
Weapon type causing fatal injury (WVDRS)				.560
Firearm	24 (40.00)	12 (50.00)	Referent	
Sharp	17 (28.33)	4 (16.67)	0.47 (0.10, 1.94)	
Other	19 (31.67)	8 (33.33)	0.84 (0.25, 2.80)	
Number of penetrating wounds (WVDRS)				.583
No wounds	16 (26.67)	7 (29.17)	Referent	
One wound	11 (18.33)	4 (16.67)	0.83 (0.14, 4.31)	
Multiple wounds	18 (30.00)	10 (41.67)	1.27 (0.34, 4.93)	
Unknown	15 (25.00)	3 (12.50)	0.46 (0.07, 2.53)	
Suspected alcohol use by victim (WVDRS)				.695
No	37 (61.67)	15 (62.50)	Referent	
Yes	11 (18.33)	6 (25.00)	1.35 (0.34, 4.87)	
Unknown	12 (20.00)	3 (12.50)	0.62 (0.10, 2.78)	
Homicide took place in the home (WVDRS)				.780
No	14 (23.73)	5 (21.74)	Referent	
Yes	45 (76.27)	18 (78.26)	1.12 (0.32, 4.56)	
[b]				
Perpetrator status after homicide (WCADV)				.935
Alive	34 (56.67)	15 (62.50)	Referent	
Committed suicide	20 (33.33)	7 (29.17)	0.79 (0.23, 2.52)	
Other	6 (10.00)	2 (8.33)	0.76 (0.07, 4.92)	
Geographical Characteristics	**Urban (n = 60, 71%)**	**Rural (n = 24, 29%)**	**Unadjusted odds ratio (95% CI)**	***P* value**
	(n, %)	(n, %)		
Concentrated disadvantage index (census 2000)				.804
Lowest tertile	11 (18.33)	6 (25.00)	Referent	
Middle tertile	15 (25.00)	5 (20.83)	0.61 (0.12, 3.16)	.720
Highest tertile	34 (56.67)	13 (54.17)	0.70 (0.19, 2.82)	.552
Instability (Census 2000)				.032[a]
Lowest tertile	7 (11.67)	7 (29.17)	Referent	
Middle tertile	24 (40.00)	12 (50.00)	0.50 (0.11, 2.13)	.339
Highest tertile	29 (48.33)	5 (20.83)	0.17 (0.03, 0.88)	.024[a]

[a]Significant at alpha = .05. [b]2 missing values.

(high to low instability OR = 0.08, 95% CI = [0.01, 0.63]). A comparison of our model findings to census-derived odds ratios (Table 5) reveals that the effects we find for race and marital status are stronger than the differences we would expect given the overall patterns of these demographic features in rural and urban Wisconsin environments. In addition, the effect we find for highly unstable residential environments is stronger than what would be expected given our knowledge of patterns of residential instability in Wisconsin.

Substitution of perpetrator relationship for marital status (see Table S1) did not substantially change the effects of neighborhood-level factors, nor the effect for race. Perpetrator relationship as husband was marginally significantly associated with rurality, when compared to relationship as boyfriend.

Discussion

Evidence suggests linkages between characteristics of residential environments and IPV. Evidence also suggests that while geographic setting may be associated with partner violence in both urban and rural settings, the nature of the influence may be different. Here, we begin to empirically examine the differences between urban and rural residential environments associated with IPF.

We find that a commonly used measure of disadvantage differs in urban versus rural environments (Table 2). When taking rurality into account in defining disadvantage, we find no difference between urban and rural IPFs in terms of their exposure to disadvantage. This finding raises a number of questions for future research. First, do commonly used measures of concentrated disadvantage

Table 5 Models Differentiating Urban and Rural Intimate Partner Femicides Using Marital Status (n = 84)

Characteristic	Model 1: Individual-Level Model Using Marital Status % Correctly classified: 78.6% Area under curve (AUC): 0.71 OR (95% CI), *P* value	Model 2: Individual-Level Model With Neighborhood Disadvantage % Correctly classified: 79.8% Area under curve (AUC): 0.80 OR (95% CI), *P* value	Model 3: Individual-Level Model With Residential Instability % Correctly classified: 75.0% Area under curve (AUC): 0.83 OR (95% CI), *P* value	Model 4: Individual-Level Model With Neighborhood Disadvantage And Residential Instability % Correctly classified: 79.8% Area under curve (AUC): 0.84 OR (95% CI), *P* value	Unadjusted Odds Ratios Based on US Census 2000 Proportions of Wisconsin Women
Victim's age					
16-24	Referent	Referent	Referent	Referent	Referent
25-34	0.67 (0.11, 4.07)	0.73 (0.11, 4.63)	0.62 (0.09, 4.20)	0.83 (0.11, 6.52)	0.92 (0.91, 0.93)
35-44	1.53 (0.30, 7.83)	1.62 (0.30, 8.59)	1.31 (0.24, 7.03)	1.37 (0.23, 7.97)	1.06 (1.05, 1.07)
45+	0.38 (0.06, 2.42)	0.44 (0.06, 3.13)	0.26 (0.04, 1.93)	0.38 (0.05, 3.04)	1.26 (1.25, 1.27)
	Overall *P* value = .332	Overall *P* value = .462	Overall *P* value = .277	Overall *P* value = .552	(Women age 16+)
Victim's race					
White	Referent	Referent	Referent	Referent	Referent
Other	0.15 (0.04, 0.57)[a]	0.14 (0.03, 0.55)[a]	0.13 (0.03, 0.54)[a]	0.08 (0.02, 0.41)[a]	0.23 (0.22, 0.24)
	Overall *P* value = .006	Overall *P* value = .005	Overall *P* value = .005	Overall *P* value = .002	(Women age 18+)
Victim's marital status					
Never married	Referent	Referent	Referent	Referent	Referent
Married	7.04 (1.61, 30.88)[a]	7.19 (1.61, 31.99)[a]	7.76 (1.59, 37.91)[a]	8.68 (1.63, 46.22)[a]	1.64 (1.62, 1.65)
Divorced/widowed	1.84 (0.29, 11.59)	1.79 (0.28, 11.37)	1.90 (0.26, 14.09)	1.74 (0.23, 13.33)	1.42 (1.41, 1.44)
	Overall *P* value = .018	Overall *P* value = .018	Overall *P* value = .018	Overall *P* value = .016	(Women age 18+)
Victim's level of education					
Less than HS degree	Referent	Referent	Referent	Referent	Referent
HS degree	3.14 (0.51, 19.36)	3.18 (0.51, 19.70)	2.22 (0.32, 15.46)	1.97 (0.27, 14.27)	1.09 (1.08, 1.10)
Some college or higher	1.49 (0.22, 9.97)	1.61 (0.24, 11.04)	0.91 (0.12, 7.07)	0.95 (0.12, 7.76)	0.73 (0.72, 0.74)
	Overall *P* value = .328	Overall *P* value = .356	Overall *P* value = .373	Overall *P* value = .541	(Women age 18+)
Concentrated disadvantage index	[b]		[b]		[c]
Least disadvantage		Referent		Referent	Referent
Moderate disadvantage		1.27 (0.24, 6.84)		1.50 (0.26, 8.56)	4.12 (4.09, 4.15)
Most disadvantage		1.51 (0.33, 6.96)		4.15 (0.68, 25.51)	1.75 (1.73, 1.76)
		Overall *P* value = .870		Overall *P* value = .281	(Women age 18+)
Residential instability	[b]	[b]			[c]
Least instability			Referent	Referent	Referent
Moderate instability			0.58 (0.12, 2.81)	0.47 (0.09, 2.15)	0.81 (0.80, 0.82)
Most instability			0.17 (0.03, 0.97)*	0.08 (0.01, 0.63)*	0.28 (0.28, 0.28)
			Overall *P* value = .106	Overall *P* value = .043	(Women age 18+)

[a]Significant at alpha = .05.

[b]These variables were not examined in this particular model, so there is no data.

[c]A direct comparison between model results and odds ratios derived from US Census data for deprivation and instability may not be appropriate because the tertiles for these measures as included in the models were computed separately for urban and rural IPF victims.

*Missing value.

reflect the nature of rural poverty? Rural poverty is often linked to different economic factors than urban poverty, with occupational categories such as agriculture taking a more prominent place. Future work should identify measures that most appropriately capture the nature of rural poverty. Furthermore, should neighborhood definitions have similar geographical sizes in rural and urban areas, and does the concept of a "neighborhood" have equal relevance in each setting? A recent systematic review considered different approaches to defining rural environments, including administrative boundaries and distance measures, finding a range of approaches currently in practice.[50] Finally, how does one best define rurality itself? Little consensus exists in the literature; the measure used here is imperfect and to some degree dependent on a small sample size. We do not distinguish different degrees (small town, rural, remote) or types (farm, non-farm) of rurality. Future work should examine both spatial and conceptual definitions of rural environments.

Regarding residential instability, we find that higher levels of instability are linked with urbanicity, even after crafting a measure of residential instability that accounts for differences between urban and rural areas. Although instability has been used to indicate potential disruption of neighborhood social cohesion and increased violence risk, this may not hold true in rural areas. In rural settings, residential stability could be an indication of entrenched social relationships similar to the notions of lack of privacy and anonymity cited as a problem for rural women experiencing IPV.[42] With little change in residence over time and low population density, it is likely that a woman and her abuser are known to many in their neighborhood or region, including police, judicial representatives, health care providers, and shelter or safe house personnel.[36] Overall, our findings indicate the possibility of a different role for neighborhood context in affecting intimate violence risk in rural settings, and suggest that different measures may be needed to capture the qualities of rural environments that affect intimate violence risk.

In addition to our findings regarding neighborhood residential environments, there are additional results worth emphasizing. In our study area, as illustrated in our census-based comparisons, non-white race/ethnicity is a feature of urban populations. In addition, although marital status differs among both our study population and the population of Wisconsin generally—with more rural women than urban women reported as married—the impact of IPF on children is similar and strong (50% of deaths). Perpetrator suicide is a significant factor in IPFs (32%). Firearms may play a larger role in rural areas (54% rural, 40% urban), although our sample size would not allow for the detection of this difference. Others have suggested that firearms are more prevalent in rural areas and may play a larger role in IPV.[37] It is known that alcohol use by the victim is known *not* to be a factor in 62% of deaths. IPFs predominantly take place in the home (75%) and relationships are often in some stage of dissolution (58%), with a partner leaving the relationship often a catalyzing event. History of IPV is known more often in urban (50%) than rural (33%) deaths, which may be attributable to under-reporting in rural areas; our analysis was unable to determine whether this is due to an actual difference in patterns of violence or because of more effective reporting or documentation in urban areas. Finally, we find that marital status does not measure the same quantity as relationship with the perpetrator. Future work should identify new approaches to capture the nature of intimate relationships and how they relate to IPV and IPF risk.

Our analysis is subject to some important limitations. The small sample size and resulting lack of clustering by neighborhood limited our ability to utilize multilevel modeling or related analysis approaches. The small sample size also affected our ability to detect more subtle differences that may differentiate urban and rural IPFs. In addition, it is well known that the choice of neighborhood definition may affect analysis results[51]; given the small sample size and inability to utilize analysis strategies that would allow a more complete consideration of geographical variation, we elected to consider only the census tract. RUCA codes are available for census tract, postal (ZIP) code, and county, and we considered census tract to be the most appropriate of these definitions given its size and relative stability over time.[52] Rurality can be defined in numerous ways. Researchers with access to larger databases should consider a more refined definition of urban and rural, for instance including a separate category for suburban deaths or considering variation across the spectrum of rurality. We analyzed victim data from 2004 to 2008 in concert with census data from the year 2000; this temporal mismatch could introduce error. Our sample was limited to Wisconsin residents, and it cannot be directly generalized to other populations.

Boyle et al recently argued: "Given that IPV is a product of social context, it is not at all clear that traditional medical approaches such as individual screening and intervention will represent effective or efficient strategies for reducing IPV. An alternative is to focus on the social determinants of IPV with a view to identifying modifiable characteristics for prevention."[53] We agree with this sentiment and with other researchers[54] who argue that a future direction for research relating neighborhood residential environments to health should focus on modifiable characteristics of neighborhoods to have the most impact on policy, practice, and eventually prevention. With

regard to IPV, future work should consider resource access and emergency response, among other factors, and should include a more thorough examination of nonurban settings. Our findings reinforce the argument that multilevel strategies will be required to understand and reduce the burden of intimate violence, and that interventions may need to be crafted for specific geographical contexts.

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Supporting Information

Additional supporting information may be found in the online version of this article:

Table S1 Models Differentiating Urban and Rural Intimate Partner Femicides Using Relationship With Perpetrator (n = 84)

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