Understanding Suicide in Pregnant and Postpartum Women, Using the National Violent Death Reporting System Data: Are There Differences in Rural and Urban Status?

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Abstract

Background: Suicide rates in the United States have increased by 30% since 1999 and suicide is currently the 10th leading cause of death. Suicide has also become one of the leading causes of death in pregnant and postpartum women. The aim of this study is to examine whether rurality affects the risk of suicide in pregnant and postpartum women. **Methods:** This study used data from the National Violent Death Reporting System, Restricted Access Dataset (2003-2012). Bivariate and multivariate analyses were used to first describe the pregnant and postpartum population versus non-pregnant females (ages 15 - 54), who all died by suicide, and then to examine urban-rural differences. **Results:** Rural suicide decedents were much older, married, less likely to have had a mental health diagnosis, and more likely to use a firearm. Recent intimate partner crisis and intimate partner problems were both associated with increased odds that the suicide decedent was pregnant or postpartum in both urban and rural counties, whereas presence of job problems and report of history of suicide attempt decreased the odds that the suicide decedent was pregnant or postpartum in both urban and rural counties. Multivariable polytomous logistic regression analyses revealed differences in suicide risk factors among pregnant, postpartum and non-pregnant decedents when stratified by rural and urban status. **Conclusion:** Our findings suggest that pregnant and postpartum women should be screened for risk of suicide, in the clinical setting, especially if there are intimate partner problems or a crisis. With proper identification and response, suicide in pregnant and postpartum women might be decreased.

1. Introduction

Suicide during pregnancy and the postpartum period is the major public health problem worldwide and in the United States (U.S.) [1]. Such fatal events are tragic to not only the victim, but also profoundly impact the baby, family and community [1]. In the U.S., suicides were the fourth leading cause of death among women between the ages of 15 - 54 years in 2012 [2]. During that same year, suicides were the second leading cause of death among girls 15 - 19 and 20 - 24 years, the third leading cause of death among women 25 - 29 years, the fourth leading cause of death among women 30 - 39 years, and the fifth leading cause of death among women 40 - 54 years [2]. Although women have lower rates of mortality from suicide compared to men, female suicide-fatality rates have not decreased in recent years [2]. Between 2010 and 2012, the age adjusted rates of suicides among women of reproductive ages 15 - 54 years (whether pregnant or non-pregnant) increased from 6.72 per 100,000 people to 7.38 per 100,000 people [2].

Studies examining suicide among pregnant and postpartum women report lower risk of suicide and suicide attempts among this group compared to non-pregnant women [3] [4] [5]. Self-harm ideation, *i.e.* "thoughts of self-harm", however, is reported to be more common than suicide attempts or deaths among this group and has been estimated to be as high as 15% in pregnant, and 14% in postpartum women [4]. Furthermore, studies report that although suicide and attempts are lower among pregnant and postpartum than in non-pregnant/non-postpartum women, suicides, when they do occur, account for 1% - 20% of total deaths of pregnant or postpartum women [3] [4] [5].

Pregnancy and the postpartum period make women more vulnerable to mental health problems. Studies attribute the increased risk of suicide among pregnant and postpartum women to the higher rate of psychiatric disorders [6] [7] and higher levels of depressive symptoms [8] [9] [10] during the perinatal period. Estimates of the prevalence of depression and anxiety disorders among pregnant and postpartum women vary widely affecting 13% - 20% [11] [12] and 10% - 12% [13] of pregnant and postpartum women respectively. Suicide, however, is a complex behavior associated with various contributing factors. Apart from demographic factors such as unemployment, race/ethnicity, age, gender, marital status, and lower education, several studies have examined and identified substance abuse, intimate partner problems, social, economic, clinical, psychiatric, and precipitating life events as risks factors for suicides [14] [15] [16] [17]. Residence status, specifically, residence in rural areas has also been reported as a significant known risk factor for suicide [18] [19] [20]. The aforementioned stu-

dies showed higher rates of suicide in rural areas particularly among men and children [18] with barriers to treatment, socioeconomic disparities, social isolation, substance abuse and access to firearms as reasons for the higher rates of suicide in these areas [19] [20].

Presently, there is a dearth of research on the determinants of suicide among pregnant, postpartum and non-pregnant women from rural and urban counties in the U.S. There is therefore, very little known about how suicide risk factors differ among these women from rural or urban counties in the U.S. Previous studies of suicide among women have been limited by: 1) studies restricted to localized samples, such as single state or city data, or data restricted to either urban or rural locations; 2) little information regarding precipitating circumstances to these deaths; and 3) likely underreporting of maternal violent deaths, especially due to reliance on death certificates alone (which may vary by state and contain missing information in the cause-of-death section) [21]. In the present study, we examined whether rural-urban county status modifies measures of association between suicide risk factors and pregnancy status among pregnant, postpartum and non-pregnant female suicide decedents aged 15 - 54 years for the years 2003 to 2012.

2. Methods

2.1. Data Source Description

Data from the National Violent Death Reporting System (NVDRS) Restricted Access Dataset (RAD) were used for this study. The NVDRS is a population based, active surveillance system established by the Centers for Disease Control and Prevention (CDC) in 2002, to collect detailed and timely information on all violent deaths from participating U.S. states [22]. The types of violent deaths recorded include suicides, homicides, homicides followed by suicides, and deaths resulting from child maltreatment or intimate partner violence, as well as "deaths where individuals are killed by law enforcement in the line of duty, unintentional firearm injury deaths, and deaths of undetermined intent" [23].

The NVDRS is unique in that it is the first surveillance system to provide detailed information on: 1) precipitating circumstances of violent deaths; 2) victim and suspect characteristics such as relationship between victim and suspect; 3) weapon type; 4) toxicology reports; 5) historical mental health diagnoses; and 6) law enforcement and/or coroner/medical examiner narratives [22]. The CDC makes some of these data available in aggregate (so that individuals cannot be identified) via its interactive web-based system: Web-based Injury Statistics Query and Reporting System (WISQARS) [24]. For this study, we obtained an individual-level Restricted Access Dataset (RAD), which includes data from 18 states (California concluded its participation in 2009) from 2003 to 2012. The RAD also contains more detailed information such as the county of residence of the decedent [25].

2.2. Variable Definition and Measurement

Suicide is defined by the NVDRS as death resulting from the use of force against oneself when the preponderance of the evidence indicates that the use of force was intentional [26]. Cases were identified using the corresponding ICD-10 codes and were then included in the NVDRS (X60-X84 and Y87.0) [26].

2.3. Rural-Urban Status

Rural-urban residence status was determined by matching each case to the degree of rurality of the decedent's county of residence using the INCITS 31-2009 23 (formerly the Federal Information Processing Standards (FIPS)) codes and the 2013 Rural-Urban Continuum Codes developed by the US Department of Agriculture [27]. The RUCC assigns each U.S. county one of nine mutually exclusive classification codes, which are determined by the county's population size and proximity to metropolitan areas [27].

The nine categories are: 1 = Counties in metro areas of 1 million population or more; 2 = Counties in metro areas of 250,000 to 1 million population; 3 = Counties in metro areas of fewer than 250,000 population; 4 = Urban population of 20,000 or more-Adjacent to a metro area; 5 = Urban population of 20,000 or more-Not adjacent to a metro area; 6 = Urban population of 2500 to 19,999-Adjacent to a metro area; 7 = Urban population of 2500 to 19,999-Not adjacent to a metro area; 8 = Completely rural or less than 2500 urban population-Adjacent to a metro area; 9 = Completely rural or less than 2500 urban population-Not adjacent to a metro area (USDA ERS, 2016). For this analysis, the RUCC codes were collapsed into urban (codes 1 - 3) and rural (codes 4 - 9) designations. Responses were then recoded in the data set as 0 = urban, 1 = rural.

2.4. Pregnancy Status

The primary outcome variable was the pregnancy status of the suicide decedents. For the purpose of this analysis, pregnant at the time of death was defined to include: "pregnant at the time of death, and "pregnant, not otherwise specified"; postpartum at the time of death was defined to include "not pregnant but pregnant within 42 days of death" and "not pregnant but pregnant 43 days to 1 year before death"; and not pregnant at time of death was defined to include "not pregnant within last year" and "not pregnant, not otherwise specified."

2.5. Risk Factors

The suicide characteristics of interest in this study were: alcohol use suspected at time of death, alcohol abuse, other substance (non-alcohol related) abuse problem, intimate partner problem, presence of a crisis within the last two weeks prior to injury, problems with finances, physical health, job problems, history of suicide attempt, whether the victim disclosed intent to die by suicide, type of weapon, injury that occurred in the decedent's home, current mental health problem and current depressed mood.

2.6. Socio-Demographic Variables

Socio-demographic characteristics that were examined in this study were age, race, education level, and marital status at the time of death of the decedents.

2.7. Data Analysis

For the purposes of this study, we limited our analysis to women of reproductive age (15 - 54 years) from the 18 states reporting complete data to the National Violent Death Reporting System. Chi-square tests of independence were conducted to compare the socio-demographic, suicide risk factors, as well as suicide event location and type of weapon used by the suicide decedents between the two residence groups (urban vs rural). Chi-square tests of independence were also used to identify the distribution of pregnant, postpartum and non-pregnant suicide decedents in urban and rural counties in the study. Fisher's Exact Probability Test was used for categorical variables that did not meet the minimum expected cell frequency of five or greater.

Multivariable polytomous logistic regression was used to estimate the adjusted odds ratio (ORs) and 95% confidence intervals (CI) of suicide risk factors among pregnant and postpartum women, with non-pregnant decedents as the reference group. Odds Ratio plots of the point estimates were generated and 95% CIs of the pregnancy risk factors of the fully adjusted model. Statistical significance was set at $p < 0.05$. All analyses were conducted using SAS 9.4® (Institute, Inc.; Cary, NC, USA).

Two approaches were then used to assess potential effect modification of risk factor associations by rural/urban residential status. In the first approach, a stratified analysis was used. The fully adjusted model was stratified by county of residence (such that data from rural and urban counties were analyzed separately) to obtain beta coefficients and ORs for pregnancy status within each stratum (urban vs rural). Odds Ratio plots of the point estimates were generated and 95% CIs of the pregnancy risk factors in the fully adjusted models for urban and rural counties (Figure 2).

In the second approach, several models were investigated by adding two-way interaction terms (between model predictors and county type) one at a time to the fully adjusted model. OR point estimates and confidence intervals were evaluated for rural and urban decedents for each predictor in the model.

3. Results

Age of suicide decedents differed by rural-urban status. Suicide decedents from urban counties tended to be younger than suicide decedents from rural counties. Compared to all suicides, the majority of the suicide decedents in urban counties were in the 15 - 34 age-group, whereas the majority of the suicide decedents in rural counties were in the 35 - 54 age-group. Education level also varied significantly among rural and urban county suicide decedents. A higher percentage of suicide decedents from rural counties had less than a high school/GED level of

education whereas a higher percentage of decedents from urban counties had completed a high school or GED level or more (Table 1).

Marital status was also significantly different among suicide decedents from rural and urban counties (p = 0.0014). In urban counties, the majority of the suicide decedents were single or never married whereas rural county suicide decedents were married, divorced, separated or other. Urban suicide decedents did not vary significantly from rural decedents in terms of race. The majority of suicide decedents in both county types were white. However, more suicide decedents in urban counties were non-white compared to decedents from rural counties. Finally, the distribution of suicide by pregnancy status was similar between rural and urban counties (Table 1).

3.1. Mental Health Characteristics

Among the 4306 decedents, 2716 (63%) were reported to have had a current mental health problem, and 2644 (61%) were noted to have had a current depressed mood. Current depressed mood and current mental health problem differed significantly among suicide decedents in rural and urban counties, with a higher percentage for each occurring among decedents from urban counties (Table 2).

Table 1. Demographic characteristics of suicide decedents in rural and urban counties.

Characteristic	All suicides n = 4306		Urban n = 3460		Rural n = 846		p-value[a]
	n	%	n	%	n	%	
Age							
15 - 34	1358	31.54	1120	32.37	238	28.13	**0.0174**
35 - 54	2948	68.46	2340	67.63	608	71.87	
Race[†]							
White	3825	88.83	3058	88.38	767	90.66	0.0591
Non-White	481	11.17	402	11.62	79	9.34	
Educational Level							
<HS[‡]/equivalent	633	14.70	458	13.24	175	20.69	**<.0001**
>HS/equivalent	3673	85.30	3002	86.76	671	79.31	
Marital status*							
M*/Divorced/Sep./Wid.	2964	68.83	2343	67.72	621	73.40	**0.0014**
Single/NM**/Unknown	1342	31.17	1117	32.28	225	26.60	
Pregnancy status							
Non-pregnant	4072	94.57	3260	94.22	812	95.98	0.0641
Pregnant	113	2.62	93	2.69	20	2.36	
Postpartum	121	2.81	107	3.09	14	1.65	

[a]p-values derived from chi-square or Fishers exact tests for categorical variables. Numbers may not add to a total of 100% due to rounding. [†]Cells suppressed for black/other/unknown races due to small number of individuals. Statistically significant association is represented in bold font. [‡]HS = High school, *M = married, **NM = never married.

Table 2. Circumstances contributing to suicides in rural and urban counties.

Circumstances	All suicides n = 4306		Urban n = 3460		Rural n = 846		p-value[a]
	n	%	n	%	n	%	
Mental health characteristics							
Current mental health problem[b]	2716	63.07	2212	63.93	504	59.57	**0.0186**
Current depressed mood[b]	2644	61.40	2162	62.49	482	56.97	**0.0032**
Substance use problems							
Alcohol problem	805	18.69	659	19.05	146	17.26	0.2317
Alcohol use suspected when injured	1189	27.61	954	27.57	235	27.78	0.9046
Other substance problem	906	21.04	736	21.27	170	20.09	0.4515
Precipitating circumstances							
Recent crisis	1033	23.99	863	24.94	170	20.09	**0.0031**
Financial problem	547	12.70	462	13.35	85	10.05	**0.0097**
Physical problem	900	20.90	741	21.42	159	18.79	0.0927
Job problem	445	10.33	376	10.87	69	8.16	**0.0202**
Suicide characteristics							
History of suicide attempt	1613	37.46	1353	39.10	260	30.73	**<0.0001**
Disclosed intent to commit suicide	1410	32.75	1160	33.53	250	29.55	**0.0272**
Intimate partner problem	1443	33.51	1181	34.13	262	30.97	0.0806
Injury occurred at victim's home	3383	78.56	2728	78.84	655	77.42	0.3667
Method of injury							
Firearm	1204	27.96	899	25.98	305	36.05	
Poisoning	1793	41.64	1458	42.14	335	39.60	**<0.0001**
Strangulation/suffocation	999	23.20	839	24.25	160	18.91	
Sharp/blunt instrument/Other	310	7.20	264	7.63	46	5.44	

[b]Medication prescription used as proxy for current mental health problem and depressed mood. [a]p-values derived from chi-square or fishers exact tests for categorical variables. Statistically significant association is represented in bold font.

3.2. Substance Use Problems

Overall, less than half of the suicide decedents were reported to have an alcohol problem, other substance abuse problems or suspected use of alcohol at the time of death was not significantly different by urban–rural residence status (Table 2).

3.3. Precipitating Circumstances

Financial problems, job problems and recent crisis within the last two weeks were more commonly cited as contributing to suicide among urban decedents. Having a history of a suicide attempt(s) or whether the decedent disclosed intent to die by suicide were both significantly more commonly reported among dece-

dents in urban counties. Problems with a current or former intimate partner contributed to more suicides among suicide decedents in urban counties compared to rural counties. Physical health problems did not significantly differ by rural-urban residence status (Table 2).

3.4. Method of Suicide/Weapon Used

The most common method of suicide was poisoning, followed by firearms, strangulation/suffocation and sharp/blunt trauma or other. Rural suicide decedents were more likely to use firearms; urban county suicide decedents were more likely to die by poisoning (Table 2).

Prior to stratification by rural and urban counties, the presence of job problems and report of history of suicide attempts were both associated with decreased odds that the suicide decedent was pregnant or postpartum compared to non-pregnant. Recent crisis and intimate partner problems on the other hand, were both associated with increased odds that the suicide decedent was pregnant or postpartum compared to non-pregnant (Figure 1). In the stratified analyses, recent crisis and intimate partner problems still increased the odds that the suicide decedent was pregnant or postpartum compared to non-pregnant in both urban and rural residents and presence of job problems and report of history of suicide attempt still decreased the odds that the suicide decedent was pregnant or postpartum compared to non-pregnant in both urban and rural residents (Figure 2).
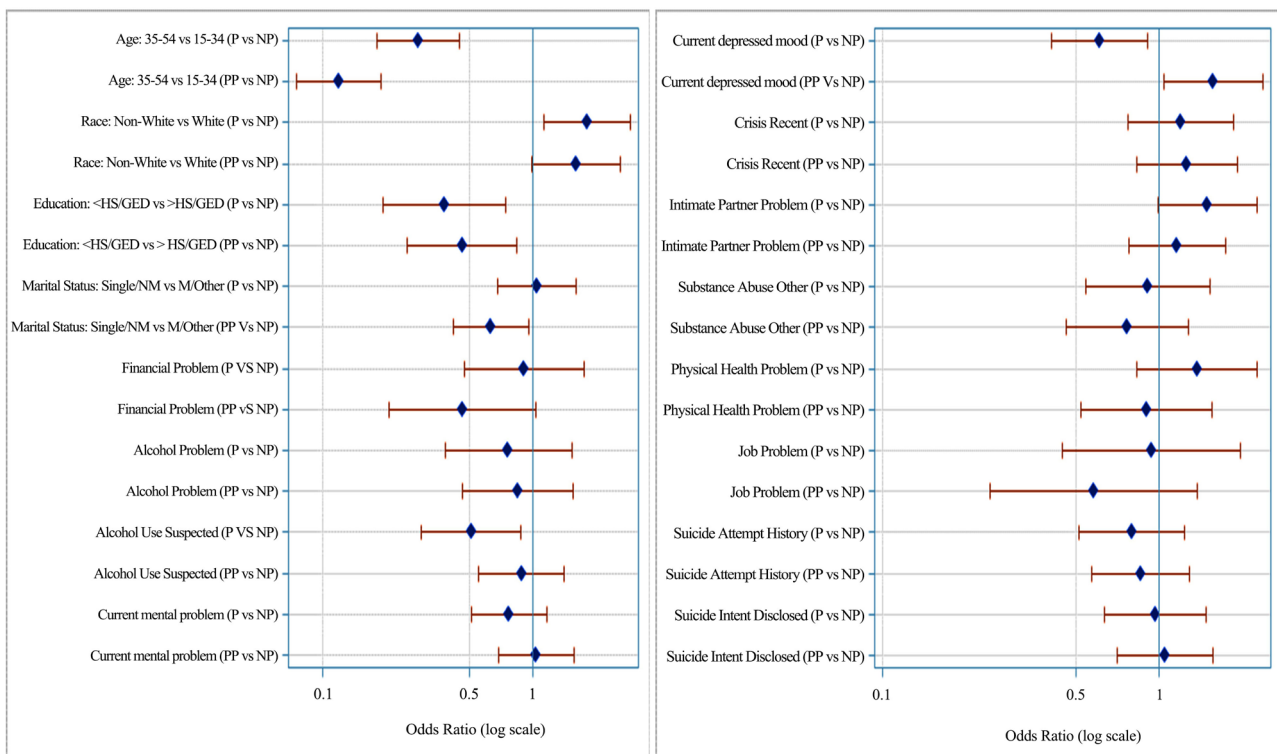

Figure 1. Odds Ratio point estimates with 95% CI from the polytomous logistic regression analysis: pregnant (P) and postpartum (PP) decedents compared with non-pregnant (NP). Rural-Urban status is not considered in this model.
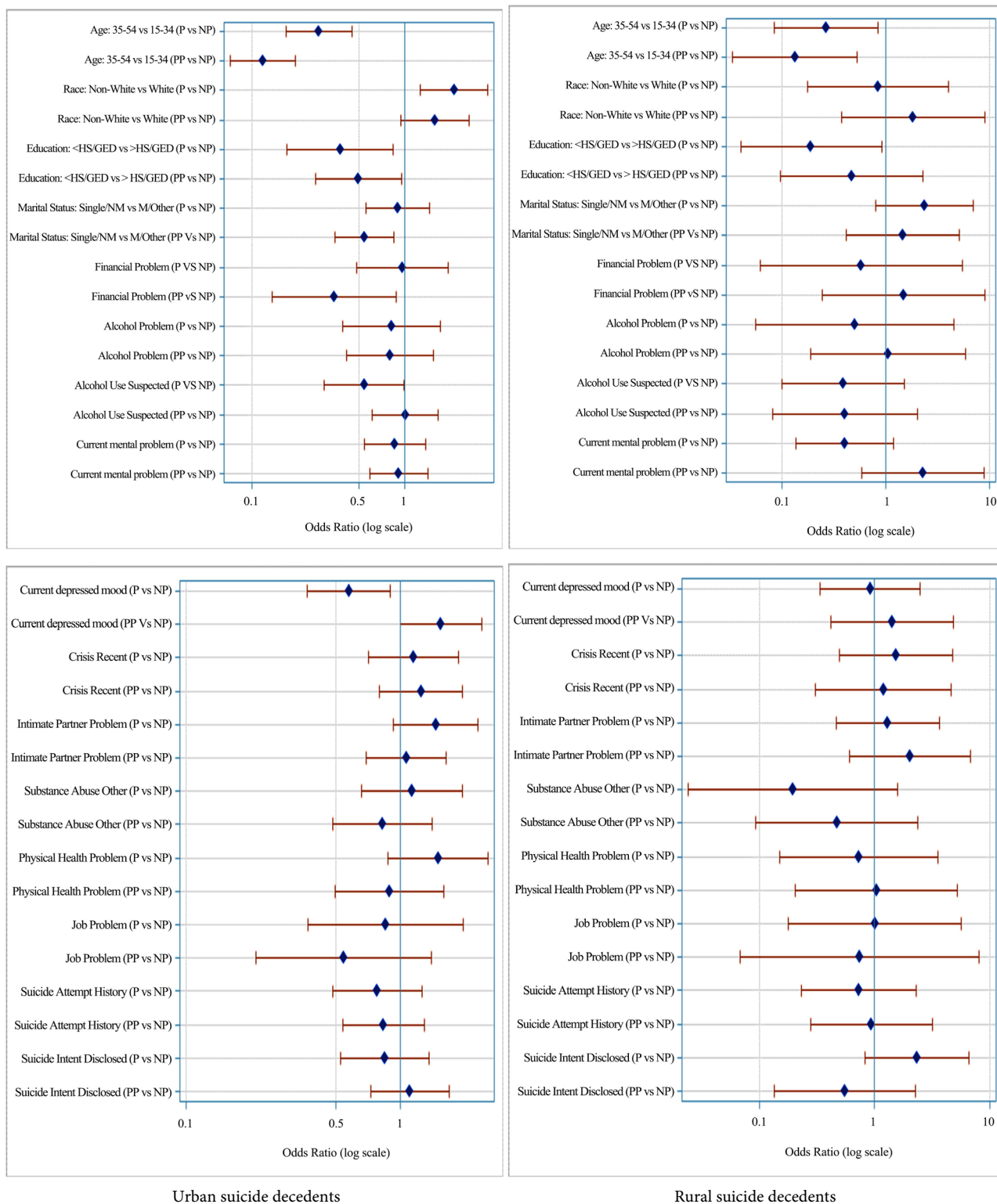
Figure 2. Odds Ratio point estimates with 95% CI from the polytomous logistic regression analysis: pregnant (P) and postpartum (PP) decedents compared with non-pregnant (NP) decedents and stratified by rural-urban status of the county of residence.

Prior to stratification, having a current depressed mood or current mental health problem was associated with decreased odds that the suicide decedent was

pregnant and increased odds that the suicide decedent was postpartum compared to non-pregnant (Figure 1). In the stratified analyses, current depressed mood was still more likely to be associated with suicide decedents who were postpartum and less likely associated with suicide decedents who were pregnant (vs. non-pregnant) in both rural and urban counties, although only the association with pregnant status in urban counties was significant. Current depressed mood increased the odds that the suicide decedent was postpartum (vs. non-pregnant) by 55% (AOR = 1.55; 95% CI 1.00 - 2.40, p = 0.0523) in urban counties and by 42% (AOR = 1.42; 95% CI 0.42 - 4.80, p = 0.5743) in rural counties. On the other hand, current depressed mood, significantly decreased the odds that the suicide decedent was pregnant (vs. non-pregnant) by 42% in urban counties (AOR = 0.58; 95% CI 0.37 - 0.89, p = 0.0141) but non-significantly by 8% (AOR = 0.92; 95% CI 0.34 - 2.50, p = 0.8625) in rural counties (Figure 2).

When stratified, having a current mental health problem however, decreased the odds (AOR = 0.92; 95% CI 0.59 - 1.41, p = 0.6919) that the suicide decedent was postpartum (vs. non-pregnant) in urban counties but increased the odds (AOR = 2.28; 95% CI 0.59 - 8.87, p = 0.2352) that the suicide decedent was postpartum (vs. non-pregnant) in rural counties. Having a current mental health problem decreased the odds that the suicide decedent was pregnant compared to non-pregnant by 13% (AOR = 0.87; 95% CI 0.55 - 1.37, p = 0.5338), in urban counties and decreased the odds by over two-fold in rural counties (AOR = 0.40; 95% CI 0.14 - 1.19, p = 0.1006) (Figure 2).

The presence of physical health problem increased the odds that the suicide decedent was pregnant by 37% (AOR = 1.37; 95% CI 0.83 - 2.26, p = 0.2189) but decreased the odds that the suicide decedent was postpartum by 10% (AOR = 0.90; 95% CI 0.52 - 1.55, p = 0.7002) (vs. non-pregnant) prior to stratification (Figure 1). When stratified, presence of physical health problems increased the odds that the suicide decedent was pregnant (AOR = 1.50; 95% CI 0.88 - 2.56, p = 0.1387) lived in an urban environment and there was also an increase inpostpartum (vs non-pregnant) (AOR = 1.04; 95% CI 0.21 - 5.25, p = 0.9612) in rural counties. Physical health problems however, decreased the odds that the suicide decedent was pregnant (AOR = 0.73; 95% CI 0.15 - 3.52, p = 0.6896) in rural and postpartum (vs non-pregnant) (AOR = 0.89; 95% CI 0.50 - 1.59, p = 0.6917) in urban counties (Figure 2).

The presence of financial problems, report of other substance abuse problems, alcohol problems, and whether alcohol use was suspected at time of injury were all associated with decreased odds that the suicide decedent was both pregnant and postpartum (vs. non-pregnant) (Figure 1). When stratified, alcohol use suspected at time of injury and other substance abuse problems decreased the odds that the suicide decedent was both pregnant (AOR = 0.39; 95% CI 0.10 - 1.50, p = 0.1698) and postpartum (AOR = 0.40; 95% CI 0.08 - 2.01, p = 0.2670) (vs. non-pregnant) in rural counties. In urban residents however, alcohol use suspected at time of injury did not change the odds that the suicide decedent was postpartum (AOR = 1.01; 95% CI 0.616 - 1.658, p = 0.9671), but it significantly

decreased the odds that the suicide decedent was pregnant (vs. non-pregnant) (AOR = 0.54; 95% CI 0.297 - 0.994, p = 0.0476). Other substance abuse problems increased the odds that the suicide decedent was pregnant by 13% (AOR = 1.13; 95% CI 0.66 - 1.94, p = 0.6596), but decreased the odds that the suicide decedent was postpartum (vs non-pregnant) by 17% (AOR = 0.83; 95% CI 0.48 - 1.41, p = 0.4829) in urban counties. Financial problems decreased the odds that the suicide decedent was pregnant (AOR = 0.97; 95% CI 0.49 - 1.93, p = 0.9283) and postpartum (AOR = 0.35; 95% CI 0.14 - 0.88, p = 0.0251) in urban counties, and pregnant (vs. non-pregnant) (AOR = 0.58; 95% CI 0.06 - 5.44, p = 0.6329) in rural counties. Financial problems, however, increased the odds that the suicide decedent was postpartum (AOR = 1.49; 95% CI 0.24 - 8.99, p = 0.6663) compared to non-pregnant in rural counties (Figure 2).

Finally, whether the decedent disclosed intent to die by suicide decreased the odds that the suicide decedent was pregnant and increased the odds that the suicide decedent was postpartum (vs. non-pregnant), albeit not statistically significant (Figure 1). When stratified, whether the suicide decedent disclosed intent to die by suicide was associated with decreased odds that the suicide decedent was pregnant in urban counties and postpartum in rural counties. Disclosure of suicide intent, however, increased the odds that the suicide decedent was postpartum (AOR = 1.11; 95% CI 0.73 - 1.69, p = 0.6275) in urban and pregnant (vs. non-pregnant) (AOR = 2.33; 95% CI 0.82 - 6.58, p = 0.1112) in rural counties (Figure 2).

The interaction effect of having current depressed mood and alcohol use suspected at time of injury, for pregnant (vs. non-pregnant) status was significantly different between urban and rural residence status. Also, the interaction effect of presence of financial problems for postpartum (vs. non-pregnant) status was significantly different between urban and rural residence county (Table 3).

4. Discussion

In this study, county status altered the association between suicide risk factors and pregnancy status of the decedents. The results, however, did not indicate a significant difference in rural-urban status and association of risk factors by pregnancy status although suicide risk factors appeared to be more prevalent in urban counties. Furthermore, by analyzing only decedents, we cannot estimate the magnitude of such risk factors in the general population of pregnant, postpartum, and non-pregnant women who did not die by suicide in each area.

Although maternal deaths due to direct causes (those caused by complications during pregnancy, such as bleeding or infection) have declined over the years, maternal deaths due to indirect causes (those caused by pre-existing physical and mental health conditions such as suicide) have not seen a corresponding decline. Suicide has become a leading cause of death in pregnant and postpartum women [21]. Suicides are preventable, hence, providers should be alert to these risk factors and consider urban vs. rural residency.

Table 3. Stratum-specific odds ratio point estimates with 95% CI from the polytomous logistic regression analysis: pregnant and postpartum victims compared with non-pregnant victims with county interaction terms.

Effects	Pregnant vs. Non-pregnant	Postpartum vs. Non-pregnant
	Adjusted OR[a] (95% CI)[b]	Adjusted OR[a] (95% CI)[b]
Current depressed mood		
at county = Rural	0.77 (0.31 - 1.94)	1.52 (0.61 - 3.76)
at county = Urban	**0.59 (0.38 - 0.91)**	1.58 (1.01 - 2.46)
Current mental problem		
at county = Rural	0.51 (0.20 - 1.28)	1.52 (0.62 - 3.75)
at county = Urban	0.85 (0.54 - 1.34)	0.95 (0.61 - 1.49)
Alcohol use suspected		
at county = Rural	0.46 (0.18 - 1.23)	0.82 (0.33 - 2.07)
at county = Urban	**0.53 (0.30 - 0.94)**	0.80 (0.54 - 1.48)
Alcohol problem		
at county = Rural	0.35 (0.05 - 2.62)	0.56 (0.13 - 2.41)
at county = Urban	0.86 (0.42 - 1.78)	0.91 (0.48 - 1.72)
Substance abuse other		
at county = Rural	0.23 (0.03 - 1.71)	0.37 (0.09 - 1.56)
at county = Urban	1.08 (0.64 - 1.84)	0.86 (0.51 - 1.47)
Financial problem		
at county = Rural	0.63 (0.08 - 4.77)	1.12 (0.26 - 4.89)
at county = Urban	0.94 (0.48 - 1.86)	**0.38 (0.15 - 0.95)**
Job problem		
at county = Rural	1.31 (0.30 - 5.78)	0.74 (0.10 - 5.64)
at county = Urban	0.86 (0.38 - 1.96)	0.55 (0.22 - 1.41)
Physical health problem		
at county = Rural	0.81 (0.20 - 3.39)	0.60 (0.14 - 2.54)
at county = Urban	1.49 (0.89 - 2.51)	0.96 (0.54 - 1.71)
Recent crisis		
at county = Rural	1.50 (0.63 - 3.59)	0.95 (0.33 - 2.69)
at county = Urban	1.16 (0.73 - 1.86)	1.31 (0.85 - 2.04)
Intimate partner problem		
at county = Rural	1.54 (0.73 - 3.24)	0.96 (0.42 - 2.17)
at county = Urban	1.43 (0.93 - 2.21)	1.20 (0.79 - 1.82)
Suicide attempt history		
at county = Rural	0.76 (0.30 - 1.94)	0.67 (0.26 - 1.69)
at county = Urban	0.81 (0.51 - 1.28)	0.89 (0.59 - 1.36)
Suicide intent disclosed		
at county = Rural	1.50 (0.70 - 3.22)	0.52 (0.16 - 1.67)
at county = Urban	0.89 (0.56 - 1.41)	1.15 (0.76 - 1.73)

[a]OR: Odds Ratio [b]CI: Confidence Interval. Potential confounders were factors that altered the unadjusted measure of association between the exposure and the outcome from the measure, adjusted for that variable, by 10% to 20%. The final model was adjusted for demographics: age, race, and education level. Statistically significant association is represented in bold font.

The demographic patterns in this study were similar to those found in the NVDRS reports from the general population. In this study, suicide decedents were predominantly older (in the 35 - 54 age group), married, and white. Data from the NVDRS also show that in the U.S., female suicide is concentrated in the 35 - 64 years age group (64.8%), with a 9.1/100,000 peak between those aged 45 - 54 years; female suicide rates were highest among Whites and women of American Indian descent. Of suicide decedents aged18 years and older, 34.5% were married, 29.7% had never married, and 21.6% were divorced at the time of death [28].

Only one U.S. study has examined rural–urban patterns in suicide risks among both males and females, characterizing the demographic, socioeconomic, and mental health features of individual suicide decedents by urban–rural residence status [18]. White women accounted for most suicide decedents in urban, rural adjacent, and rural not adjacent areas; decedents in both rural categories were less likely to have had a relationship status of never married [18]. The demographic findings in that study are also similar to the demographic characteristics of this present study.

The possible explanations for the lower rates of mental health diagnosis among rural decedents have been explored in several studies. According to Fiske, Gatz, & Hannell (2005), rural individuals are less likely to be diagnosed with and receive treatment for mental health problems because of the scarcity of health and mental health treatment providers in rural areas [29]. Furthermore, Crawford, & Brown (2002) attributed the lower rates of mental health diagnoses among rural decedents to the stigma attached to mental illness in rural communities [30]. Consequently, those suffering from mental illness may isolate themselves rather than seek help from their community. Lastly, the theory of greater social isolation in rural communities by Trout (1980) may explain the reduced rate of mental health diagnosis [31]. Physical isolation from social networks and support services in rural areas makes it less likely that an at-risk individual will be identified [31].

Several predictors have been evaluated in the literature to explain why depressed mood might pose a higher risk in postpartum women compared to other women. In these studies, the strongest predictors of postpartum depression included poor marital relationship, low social support, stressful life events, depression and anxiety during pregnancy and previous history of depression [32]. It is not known why current mental health problems increased the odds of postpartum (vs. non-pregnant) status in rural counties. It is possible, however, that postpartum decedents from the rural counties under study may have had comparable rates of current mental health problems to postpartum decedents from urban counties but were somehow less able to cope with them.

Alcohol is reported as a major factor in suicides [33]. Although alcohol and other substance abuse problems were associated with decreased odds of observing pregnant and postpartum status in both urban and rural counties, compre-

hensive and culturally appropriate suicide-prevention strategies are still needed in both rural and urban counties that include efforts to reduce alcohol consumption.

The relationship between suicide and life events is complex [34]. Prior studies have shown an association between suicides and life events in the previous three months, and particularly in the previous week [35]. These life events were specifically associated principally with interpersonal, job, financial, and legal problems [36] and therefore indicates the need for multiple adverse life events to be taken into account in suicide risk assessment and treatment.

The decedent having disclosed intent to die by suicide, decreased the odds that the suicide decedent was pregnant and increased the odds that the suicide decedent was postpartum compared to non-pregnant. Although it is unclear what the implication of this difference is, disclosure of suicide intent is an important warning sign of suicidal intentions and persons in close contact with potential victims of suicide need to be educated about the significance of these warnings and how to respond.

In this study, intimate partner problems were also cited as a precipitating factor with a higher percentage among urban decedents than rural decedents. This finding is consistent with previous research where both pregnant and postpartum women were more frequently reported as having problems with a current or former intimate partner [21]. The perinatal period is a time when health care providers have recurrent encounters with pregnant and postpartum women, therefore, screening for partner violence during and after pregnancy can help lower or prevent violent deaths among potentially at-risk women [21].

The most common method of suicide was poisoning, followed by firearms, strangulation/suffocation and sharp/blunt trauma or other. Data from the NVDRS also show that in the U.S., among females, poisons were used most often (40.7%) followed by firearms (31.3%) [28]. Furthermore, rural suicide decedents were more likely to use firearms whereas urban county suicide decedents were more likely to die by poisoning. This is also consistent with prior studies where rural decedents were more likely to use a firearm as the method of suicide [18] [20].

Several limitations should be taken into account when interpreting the results. The analysis for this study includes data from 18 states. Therefore, the results may not be generalizable to other populations in the other states. Secondly, all study subjects in the NVDRS are deceased and cannot be interviewed after death so it is impossible to assess for all current mental health disorders, thoughts about suicide intent, or precipitating factors [18]. Information regarding mental health, substance use, intimate partner problems or other precipitating circumstances are obtained from the reports of families and friends of the deceased without independent verification, and hence may be subject to lack of relevant knowledge, response bias, and recall bias [17]. In addition, the accuracy of reporting of suicide risk factors may vary by urban-rural status and the structure

of the NVDRS does not allow for control of such variability [18].

The third major limitation is that approximately 62% of the pregnancy status field was coded as "unknown" pregnancy status and were excluded from the study. As a result, some women who would have been classified as either pregnant or postpartum may have been misclassified into the unknown pregnancy group rather than correctly assigned to the right pregnancy group. Thus, this misclassification may have underestimated the number of pregnancy-associated suicides and resulted in non-differential bias, which may have reduced the estimate towards the null.

As previously discussed, there is a great deal of variation in how the terms rural and urban are defined. This is because proximity to urban centers might mitigate the potential risk factors that exist in the rural setting (such as limited access to treatment), and therefore, differences exist in risk factors for suicide among women living in completely rural or rural adjacent areas. Using a dichotomous category for residence status as in the case of this study makes it difficult to distinguish such differences and may also give a pooled estimate of risk factors for suicide which might be similar to those of urban women and will lead to failure to reject the null hypothesis (Type 1 error). Future research should include alternative measures of rural status that takes into account duration of residence and proximity to urban centers.

Lastly, only information on suicide decedents is reported in the NVDRS. This analysis does not include information on other pregnant, postpartum and non-pregnant individuals in the rural and urban counties under study. Thus by analyzing only decedents, a possible bias exists. Decedent characteristics may differ between pregnant, postpartum and non-pregnant suicide decedents and their counterparts who consider or attempt suicide or without any suicidal thoughts or attempts. Furthermore, the results of this study cannot be used to infer causality when looking at factors associated with suicides among pregnant, postpartum and non-pregnant decedents from rural and urban counties. To help identify individuals at risk and prevent future mortality, future studies should also compare decedents with living controls.

5. Conclusion

Despite the limitations of this study, findings from this study are useful for providing relevant information to public-health officials and healthcare providers and for guiding research and suicide prevention efforts. The current project also confirmed there are some variations in socio-demographic and suicide risk factors among pregnant, postpartum and non-pregnant decedents from rural and urban counties. In particular, compared to urban suicide decedents, rural suicide decedents were older, married, less likely to have had a mental health diagnosis and more likely to use a firearm to die by suicide. These variations may imply the need for differences in strategies for suicide prevention in rural and urban counties in the U.S.

Declarations

Ethics Approval and Consent to Participate

This study has been approved by the Institutional Review Board at the University of Kentucky. All authors have completed human subjects training.

Consent for Publication

The authors consent for publication. This paper has not been published elsewhere.

Availability of Data and Material

Data sources: CENTERS FOR DISEASE CONTROL AND PREVENTION (CDC) Restricted Access Dataset.

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Authors' Contributions

A.A. analyzed the NVDRS RAD data and wrote the manuscript with support and input from I.A. W.S. and S.B. W.S. and S.B. contributed to the interpretation of the results. S.B. provided the majority of editing, the RAD data application and submitted the manuscript. All authors provided critical feedback and helped shape the analysis and manuscript.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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