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**Cardiovascular Disease Deaths of Vermonters aged 65+ years by  
Rurality Status of Residency**

**Abstract:**

**Objective:** To analyze cardiovascular disease (CVD) mortality amongst individuals 65 years and older living in different areas of Vermont.

**Methods:** Using the state of Vermont's Electronic Death Registration System, the cross-sectional analysis compared the rate of CVD death for older Vermonters in urban and rural areas between 2015 and 2019.

**Results:** The binomial logistic regression model demonstrated statistically significant findings among the predictor variables: rurality ( $p < 0.001$ ), biological sex ( $p < 0.001$ ), hospice status ( $p < 0.001$ ), tobacco as a contributor to death ( $p < 0.001$ ), marital status ( $p = 0.033$ ), and age ( $p < 0.001$ ). The regression revealed urban deaths were 0.165 times less likely to occur from CVD-related causes than non-CVD-related causes when compared to rural deaths (OR= 0.835; CI= 0.753, 0.926).

**Conclusions:** These findings suggest a need for increased research and awareness of the impact CVD mortality has among Vermonters 65 years and older in rural areas as this population continues to increase.

**Introduction:** In the United States, it is estimated that one person dies every 34 seconds from heart disease.<sup>1</sup> Cardiovascular Disease (CVD) death is not homogenous, with recent studies projecting that adults living in urban parts of the United States have a 19% lower rate of heart failure compared to their rural counterparts.<sup>2</sup> Three out of four Vermonters live in rural counties, and CVD is the second leading cause of death.<sup>3</sup> The research question in this study was; among Vermont residents 65 years and older living in urban communities, were rates of mortality due to CVD lower as compared to Vermont residents 65 years and older living in rural communities during the period of 2015-2019?

**Methods:** We conducted a cross-sectional study to examine death certificate data from Vermont Department of Health's Electronic Death Registry System (EDRS) between 2015-2019. The EDRS is a death reporting application that allows funeral directors and health professionals to record deaths. Information on the EDRS includes, but is not limited to, demographics, method/place of bodily disposition, and death information.<sup>4</sup> Between 2015-2019, there were 26,738 deaths in Vermont, 21,012 amongst decedents 65 years and older. This study was

restricted to decedents 65 years or older that resided in Vermont at the time of death. The top 14 CVDs were identified by frequency of diagnosis and selected for this study.<sup>5,6</sup> CVD is an umbrella term for circulatory diseases that affect the heart or blood vessels.<sup>5</sup> The following ICD codes were used for the tenth revision: I09, I21-3, I25, I26, I31, I34, I35, I42, I49, I50, I51, I60-3, I71, I73, and I82. Congenital heart disease was excluded from this study because it does not fulfill the definition of circulatory system CVD for this study. Exclusion criteria were defined as missing, unknown, or not obtainable information.

The dependent variable, CVD underlying cause of death, was treated as a binary variable and was determined by the ICD-10 code listed on the decedent's death certificate. The independent variable, rurality, was treated as a binary variable and was created using the decedent's county of residence at the time of death. Rural and urban status were defined using information from the Health Resources and Services Administration.<sup>7</sup> The dataset was double checked for errors and missing values to ensure proper collection, storage, and management. This study conforms to IRB exemption criteria as established by the University of Vermont Committees on Human Research.

Descriptive analyses were used to generate tables, frequencies, and standard deviations.  $\chi^2$  Tests of Independence and bivariate crosstabulations were performed for our binary variables, including biological sex, race/ethnicity, marital status, education status, veteran status, hospice status and tobacco as a contributor to death. Age was treated as a continuous variable. We used binomial logistic regression to determine the effect of the predictors on CVD underlying causes of death and resulting Exp(B)s interpreted as Odds Ratios and corresponding 95% Confidence Intervals (CI95s). Confounders in this study included age, tobacco, education, and biological sex. Analyses used SPSS version 28 and statistics were interpreted using p-values ( $\alpha = 0.05$ ) and 95% confidence intervals.

**Results:** 14,937 deaths between 2015-2019 (Table S1) were included. Of these, 79.2% were non-CVD-related deaths (n=11827) and 20.8% were CVD-related deaths (n=3110). 78.5% of the study sample was categorized as rural and 44.7% had biological sex listed as male (n=6677). In terms of race and ethnicity, 99% were white (n=14792),

and 1% were non-white (n=145). 20% of the sample were veterans (n=2981), 35.1% were married (n=5249), and 18.5% had lower educational attainment (n=2766). Additionally, hospice care was noted for 53.3% of individuals (n=7954). Tobacco use as a contributor was categorized as 69.7% no (n=10414) and 30.3% yes/possibly (n=4523).

<b>Table 1- Results of Binomial Regression for CVD Underlying Causes of Death Among Vermonters 65+ Years with Selected Characteristics: Vermont, 2015-2019</b>	
	<b>Binomial OR (95% CI)</b>
<b>Rurality</b>	
Urban	0.84 (0.75, 0.93)
<b>Hospice Status</b>	
Yes	0.37 (0.34, 0.41)
<b>Biological Sex</b>	
Female	0.66 (0.59, 0.73)
<b>Marital Status</b>	
Married	0.90 (0.82, 0.99)

<b>Tobacco as a Contributor</b>	
Yes/Probably	1.21 (1.10, 1.32)
<b>Age</b>	1.02 (1.01, 1.02)

Note: CI = Confidence Interval, OR = Odds Ratio

Binomial logistic regression between CVD underlying cause of death and rurality. Reference categories include rural for Rurality, male for Biological Sex, other than married for Marital Status, no for Hospice Status, and no for Tobacco as a Contributor.

The logistic regression model (Table 1) demonstrated statistically significant findings among the predictor variables: rurality ( $P < 0.001$ ), hospice status ( $P < 0.001$ ), biological sex ( $P < 0.001$ ), marital status ( $P = 0.033$ ), tobacco as a contributor ( $P < 0.001$ ), and age ( $P < 0.001$ ). The regression revealed urban deaths were 0.165 times less likely to occur from CVD-related causes than non-CVD-related causes when compared to rural deaths (OR= 0.835; CI95= 0.753, 0.926). Additionally, those that received hospice care were 0.626 times less likely to die from CVD-related causes than non-CVD-related causes when compared to those that did not receive hospice care (OR= 0.374, CI95= 0.344, 0.407). Females were 0.344 times less likely to die from CVD-related causes than non-CVD-related causes when compared to men (OR= 0.656, CI95= 0.592, 0.726). 7.2% of the variance in the model was explained per the Nagelkerke R Square estimate.

**Discussion:** The results of this analysis indicated that the predictor variables of rurality, biological sex, hospice status, tobacco as a contributor, marital status, and age were all significant factors in death due to CVD amongst Vermonters 65 years and older between 2015 and 2019. Although males have higher overall rates of CVD mortality, females over 60 years had rates increase steeply. This corroborated the result of female biological sex being slightly more significant for CVD mortality.<sup>8</sup> While males have higher risk of CVD mortality during their fourth and fifth decades of life, female CVD mortality risk accelerates rapidly during the sixth decade of life.<sup>8</sup> Positive cigarette

smoking status has been well studied as a contributory factor to CVD death, as has marital status, which this study supported.<sup>9,10</sup> Those with marital status of divorced, separated, widowed, or never married are more likely to die than those who are currently married when controlling for confounders.<sup>10</sup> Additionally, the variable of hospice status was found to be significant. Previous studies have found that the proportion of CVD deaths in hospice care is increasing, and further research is needed to understand the root causes.<sup>11</sup> Therefore, the considered factors should be acknowledged as significant in further research. Those living in rural areas with female gender, positive smoking status, single marital status, older age, and positive hospice status should be considered among the most at risk groups for policymakers.

This study occupies a major knowledge gap of factors affecting CVD mortality in rural states, particularly those like Vermont. It is estimated that greater than 29% of Vermont's population will be 60 years old or older by the year 2030.<sup>12</sup> As this population continues to grow, this work provides basis for increased surveillance of risk factors and awareness of the impact CVD mortality has among Vermonters 65 years and older, particularly in rural areas. This research recognizes and attempts to address a gap in current literature concerning the challenges facing Vermonters as they age. A limitation is that these results are not generalizable to the greater United States population of 65 years and older due to the uniqueness of the population; however, the results may be generalizable to other mostly rural states.

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