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Suicides Among Farmers in Three Southeastern States, 1990-1998

S. R. Browning, S. C. Westneat, R. H. McKnight

ABSTRACT. *Several studies have documented higher rates of suicide among farmers in comparison to other occupational groups, both in the U.S. and internationally. The purpose of this study is to describe the epidemiology of farmer suicides in three southeastern states (Kentucky, North Carolina, and South Carolina) during the nine-year period 1990-1998. Electronic death certificate data were obtained from the National Center for Health Statistics. Over the nine-year period, there were 590 deaths related to suicide (E-codes: 950-959) among farmers (occupation codes: 473,474,475, 477, and 479) in the states of Kentucky, North Carolina, and South Carolina. The results of this study confirm the increased rate of suicide mortality among white male farmers in comparison to the total white male population in these three southern states. The increased rate of suicide was significantly elevated among farmers age 25-34 years (RR: 2.07; 95% CI: 1.61-2.67) and among those age 75-84 (RR: 2.04; 95% CI: 1.70-2.45) and age 85 years and older (RR: 2.67; 95% CI: 2.02-3.54) in comparison to the total white male population. The use of a firearm was the primary mechanism of death for the majority (86%) of the cases. Farmer suicide mortality rates in the southeastern U.S. are higher than in Midwestern states. The elevated rate of white male farmer suicides in North Carolina over this time period (35% higher age-adjusted suicide rate in comparison to South Carolina) suggests a need for further investigation to assess the individual, social, and economic factors that may explain this elevated rate. Interventions for the prevention of suicide need to be directed to older male farmers who consistently have higher suicide rates than similar males in other occupations.*

Keywords. *Agriculture, Farmers, Suicide mortality.*

The increased risk of unintentional injury and death among agricultural workers has been well-documented (NIOSH, 2004; Reed, 2004). The physical hazards associated with animal care and the use of tractors or other farm machinery are established occupational risks for farmers (Frank et al., 2004; McCurdy and Carroll, 2000). However, less research has focused on the psychosocial factors associated with agricultural work, including long and physically demanding work hours, unpredictable working conditions associated with weather-contingent planting and harvesting schedules, current economic conditions, and the lack of labor and financial resources, all of which may increase work-related stress and contribute to adverse health outcomes among farmers. For some groups of farmers, difficult and isolated working conditions, absence of social support, and lack of access to certain healthcare services may be associated with an increased risk for stress, depression, and in extreme cases, suicide. Research conducted

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both in the U.S. and internationally has documented higher rates of suicide deaths among farmers and agricultural workers in comparison to those in other occupations (Burnley, 1994; Malmberg et al., 1997; Page and Fragar, 2002).

Within the U.S., higher rates of farmer suicides compared to other occupations have been reported in a number of states, including Missouri and Oklahoma (Gray, 2000), Alabama (Liu and Waterbor, 1994), Iowa (Zwerling et al., 1995), and Kentucky (Stallones, 1990), as well as in the northern states of Minnesota, Montana, North Dakota, South Dakota, and Wisconsin (Pylka and Gunderson, 1992). Liu and Waterbor (1994), in an investigation that examined death certificates in Alabama over the period 1984-1989, indicated that farmers had a nearly 6-fold elevation in suicide risk compared to persons employed in public administration. Zwerling et al. (1995) found an elevated proportionate mortality ratio (PMR) of 1.20 (95% CI: 1.09-1.32) for suicides among Iowa farmers between 1980 and 1988. Pylka and Gunderson (1992) found higher suicide rates among full-time farmers (50.1 deaths per 100,000 persons) in comparison with other farm residents and laborers in Minnesota, Montana, North Dakota, South Dakota, and Wisconsin. They noted marked geographic variation in farmer suicide rates by state, with the highest rate (among the five states) in South Dakota (38.3 per 100,000 farm/ranch residents) and the lowest in Minnesota (12.9 per 100,000 farm/ranch residents). The age-adjusted standardized mortality ratio (SMR) for full-time, white male farmers was 1.70, indicating 70% more deaths from suicide among farmers than among adult white males in the U.S.

While observed in a number of studies, the finding of higher suicide rates among populations residing on farms has not been consistent across time and place. Stallones and Cook (1992) reported on-farm suicide rates in Colorado during the period 1980-1989, which were lower than for metropolitan and non-metropolitan males. International studies documented a “protective effect” among Canadian and Swedish farmers in comparison to their non-farming counterparts (Pickett et al., 1993; Thelin, 1991). Kposowa (1999) found farmers not to have higher rates of suicide in comparison to other occupational groups in the U.S.

Suicide rates differ substantially by geographic location, time period, and rural-urban gradient. Rural areas both in the U.S. and overseas (CDC, 1997; Kaplan and Geling, 1998; Saunderson et al., 1998; Singh and Siahpush, 2002) tend to have higher suicide rates than do urban areas. In the U.S., Singh and Siahpush (2002) found significant differences in age-adjusted rates of male suicide mortality by rural and urban gradients, with higher suicide rates tracking with increasing levels of rurality. Distinguishing the rural aspects of suicide mortality from those associated with occupational factors is difficult in considerations of suicide in agricultural populations.

The average age of farmers in the U.S. is approximately 55 years and has been increasing over time. The percentage of farmers age 65 and over has increased consistently since 1978 (Allen and Harris, 2005). Suicide rates generally increase with increasing age and are highest among the elderly population. Several investigators found that the highest suicide rates among farmers were among elderly farm owner operators (Pickett et al., 1993; Pylka and Gunderson, 1992). Among the risk factors investigated, the higher incidence of illnesses and injuries among this occupational group may partially account for the higher suicide rates.

Limited work has been done to examine patterns of suicide among farmers working in the southeastern U.S. The mental health of farmers has been identified as a primary issue of concern in the agricultural community (Rosmann, 2005). The purpose of this research is to examine the descriptive epidemiology of farmer suicides in Kentucky, North Carolina, and South Carolina over the time period 1990-1998. These three states are the primary producers of tobacco in the U.S., and changes in the tobacco market have

led to substantial economic and social consequences for farmers who rely on this commodity.

Materials and Methods

Computerized death certificate data were obtained from the National Center for Health Statistics (NCHS) for the years 1990-1998 for the states of Kentucky, North Carolina, and South Carolina. Variables available included age, race, gender, county of death, marital status, usual occupation, cause of death, date of death, state of residence, and place of death. While not every state codes for the usual occupation/industry of the deceased, the three states in this study code for this field in order to identify farm operators, managers, and workers (collectively referenced as “farmers” in this article).

Cases of farmer suicide deaths were abstracted from the files based on the following criteria: (1) the death occurred in North Carolina, South Carolina, or Kentucky (state of death); (2) the state of residence for the case is the same as the state of death; (3) an ICD Ninth Revision E-code of 950-959, which designates suicide and the manner of death (e.g., firearm, hanging, poisoning, etc.), was given; and (4) an occupation code of 473, 474, 475, 477, or 479 (U.S. DHHS, 1999), which identifies farm operators, managers, and workers, was provided. For most analyses in this article, we have limited the presentation of the data to white (non-Hispanic), male residents age 25 years and older of these three southern states, given the relatively few cases reported for women and for other races. Cases of all white male suicides were also abstracted from the data files for comparison to the white male farmer suicides. Analysis of the characteristics of the suicide cases by age, gender, race/ethnicity, occupational code, state of death, marital status, education, county of death, calendar year of death, and cause of death was undertaken using SAS (SAS, 1999).

In calculating suicide death rates for those persons involved in agriculture, it was necessary to develop an appropriate denominator to characterize the “at risk” population (Pylka and Gunderson, 1992). We used data estimating the number of farmers provided in each of the state-specific Census of Agriculture reports for the census years 1992 and 1997 (USDA, 2007). For the intercensal years, we estimated the total number of farmers using linear regression to interpolate between the census years, and applied the age-specific distributions of farmers from the census years to these numbers to generate age-specific estimates of white male farmers for each year from 1990-1998. Data from the Census of Agriculture were not available in age categories identical to the mortality data or the U.S. Census population estimates. Consequently, it was necessary to estimate the population of farmers for the age categories 65-74, 75-84, and 85+ by applying the age distribution from the U.S. Census to the total number of white male farmers in the 65+ age category. For the calculation of the total suicide rates among white males, we used state-specific population estimates from the U.S. Census for the period 1990-1998. Census population estimates were obtained for seven age groupings (25-34, 35-44, 45-54, 55-64, 65-74, 75-84, and 85+ years) of white males. The intercensal population estimates for the years in this study were projected in accordance with the methodology developed by the U.S. Census.

The primary comparisons made in the study were between the suicide death rates for the white male farmer population age 25 years and older and the total white male population for each state. Age, calendar time, and state-specific suicide death rates for farmers were calculated using the numbers of suicide deaths (cases) as the numerators and the estimated population of farmers from the Census of Agriculture as the denominators. For the total white male suicide rates, we used the suicide cases for all

white males as the numerator and the population census estimates for the denominator, as described above. Rates are given as the number of deaths per 100,000 persons. Age-, state-, and calendar-time adjusted rates were estimated using the GENMOD procedure available in SAS (SAS, 1999) to yield least square mean estimates of the rates. Adjusted rates were smoothed using a running median technique (Abramson and Gahlinger, 2001) and graphically presented using SigmaPlot version 8.0 (SPSS, 2001).

Poisson regression analysis was used to generate the adjusted incidence density ratios (IDRs) to evaluate the risk factors for suicide mortality. Poisson regression models were fit using the GENMOD procedure with a Poisson distribution and the log function as a link in SAS (SAS, 1999). State, calendar year, age group, and an indicator variable for farming occupation (farmer vs. total white males) were the parameters fit to the model predicting the suicide death rates. Interaction terms between state and farming occupation and between age group and farming occupation were included in the model. The incidence density ratios were obtained by exponentiating the beta coefficients from the models, and 95% confidence intervals were computed using the standard errors of the estimates. The antilog of the regression coefficient corresponds to the rate ratio comparing the farmers to the total white male population adjusted for the indicated parameters in the model.

The study was approved by the Institutional Review Board of the University of Kentucky.

Results

The case distribution of farmer suicides in Kentucky, North Carolina, and South Carolina yielded 645 deaths over the nine-year period of analysis. White male suicides ($N = 590$) composed 91.5% of all reported suicides, with black male farmers accounting for 6.4% ($N = 41$ cases) of the suicides, females accounting for 2.0% ($N = 13$ cases) of the suicides, and other male minority farmers constituting only 0.2% ($N = 1$ case) over the nine-year period. Given the small numbers of suicides among minority and female farmers, the analyses in this article are restricted to white male farmers in the three states. Eighty-nine percent (89%) of the deaths were coded with the occupational title “farmers, except horticultural”, 9% of the deaths were coded as “farm workers”, and the remaining 2% were coded as “managers, supervisors, and horticultural specialty farmers”.

For the white males ($N = 590$), 53% of the suicides occurred in Kentucky, 37.5% in North Carolina, and 9.7% in South Carolina (table 1). Over the nine-year period from 1990 through 1998, Kentucky had a mean of 34.6 white male farmer suicides per year, North Carolina had a mean of 24.6 white male farmer suicides per year, and South Carolina had a mean of 6.3 white male farmer suicides per year. Fifty-two percent of the suicides occurred among farmers age 65 years and older in the three states. Farmers with 11 or fewer years of education accounted for 50% of the suicide deaths. Less than 1% of the white male farmer suicides deaths were coded as an injury at work. The primary method of suicide death for white male farmers was use of a firearm (86%), compared to 74% of all white males in these three states who used a firearm in their death ($p < 0.0001$).

Farmer suicides among white males were more likely to occur among persons age 65 years and older, those who are widowed, and those with 8 years or fewer of education in comparison to the total white male population in these states (table 2). The highest proportion of farmer suicides in this study occurred in calendar year 1990.

Table 3 presents the crude and age-adjusted suicide mortality rates by state comparing the white male farmers to total white males. Age-adjusted rate comparisons between

Table 1. Descriptive characteristics of white male farmer suicide deaths in Kentucky, North Carolina, and South Carolina, 1990-1998.

		Kentucky (N = 312)		North Carolina (N = 221)		South Carolina (N = 57)		Total (N = 590)	
		N	%	N	%	N	%	N	%
Age (years)	15-24	9	2.9	7	3.2	1	1.8	17	2.9
	25-34	34	10.9	22	10.0	6	10.5	62	10.5
	35-44	47	15.1	21	9.5	8	14.0	76	12.9
	45-54	35	11.2	18	8.1	7	12.3	60	10.2
	55-64	36	11.5	27	12.2	5	8.8	68	11.5
	65-74	56	17.9	47	21.3	13	22.8	116	19.7
	75-84	65	20.8	54	24.4	12	21.1	131	22.2
	85+	30	9.6	25	11.3	5	8.8	60	10.2
Marital status	Married	172	55.1	111	50.2	36	63.2	319	54.1
	Single/never married	54	17.3	43	19.5	10	17.5	107	18.1
	Widowed	45	14.4	44	19.9	5	8.8	94	15.9
	Divorced	41	13.1	23	10.4	6	10.5	70	11.9
	Not stated								
Injury at work	Yes	1	0.5	1	0.7	1	3.9	3	0.9
	No	135	70.7	134	99.3	23	88.5	292	83.0
	Unknown	55	28.8			2	7.7	57	16.2
	Missing ^[a]			86		31		238	
Education (years)	0-8	95	30.5	86	38.9	18	31.6	199	33.7
	9-11	32	10.3	46	20.8	17	29.8	95	16.1
	12	58	18.6	49	22.2	15	26.3	122	20.7
	13-15	7	2.2	13	5.9	1	1.8	21	3.6
	16 or more	5	1.6	6	2.7	4	7.0	15	2.5
	Not stated	115	36.9	21	9.5	2	3.5	138	23.4

^[a] Missing values are not included in the percentage calculations for the table.

farmers and total males indicate that farmer suicide rates were higher than total male suicide rates in all three states. The rates for farmers were significantly higher in Kentucky and North Carolina, with a rate difference of 18.6 deaths per 100,000 persons per year in North Carolina. While North Carolina had the highest farmer suicide rate of the three states in the study, the largest number of suicide cases was in Kentucky.

Figure 1 illustrates the changing pattern in smoothed suicide rates between 1990 and 1998 in the three states. The decline in rates in the early 1990s is apparent in all three states. The white male farmer rates are consistently highest in North Carolina and lowest in South Carolina over the study period. The calendar trends in the rates are similar for the three states, although the magnitude of the farmer suicides rates are different and do not overlap. State-specific analysis of the time trends for the rates (not shown) indicated an elevated suicide rate for farmers compared to total white males across this time period for state-specific comparisons. The suicide rates for South Carolina white male farmers were lower than the rates for total white males for the three states combined over the entire time period.

The very youngest farmers (age 25-34) and farmers age 65 years and older had increased rates of suicide in comparison to the total white male population (fig. 2). Farmers in the 75-84 year age group were approximately twice as likely to die from suicide in comparison to the total older white male population, while farmers age 85 years and older were more than 2.5 times more likely to die from suicide.

Table 2. Comparison of total white male deaths and white male farmer suicides in Kentucky, North Carolina, and South Carolina, 1990-1998.

		Total White Males (N = 11,270)		White Male Farmers (N = 590)	
		N	%	N	%
Age (years)	15-24	1364	12.8	17	2.9
	25-34	2148	20.1	62	10.5
	35-44	2168	20.3	76	12.9
	45-54	1602	15.0	60	10.2
	55-64	1239	11.6	68	11.5
	65-74	1176	11.0	116	19.6
	75-84	791	7.4	131	22.2
	85+	192	1.8	60	10.2
Marital status	Married	5289	49.5	319	54.1
	Single/never married	2575	24.1	107	18.1
	Widowed	814	7.6	94	15.9
	Divorced	1960	18.4	70	11.9
	Not stated	42	0.4	0	0.0
Education (years)	0-8	1143	10.7	199	33.7
	9-11	1870	17.5	95	16.1
	12	3716	34.8	122	20.7
	13-15	1360	12.7	21	3.6
	16+	1214	11.4	15	2.5
	Not stated	1377	12.9	138	23.4
Year	1990	1206	11.3	96	16.3
	1991	1121	10.5	70	11.9
	1992	1199	11.2	72	12.2
	1993	1178	11.0	79	13.4
	1994	1227	11.5	44	7.4
	1995	1143	10.7	60	10.2
	1996	1244	11.7	46	7.8
	1997	1173	11.0	62	10.5
	1998	1189	11.1	61	10.3
State	Kentucky	3119	29.2	312	52.9
	North Carolina	4961	46.5	221	37.5
	South Carolina	2600	24.3	57	9.6

Table 3. Crude and age-adjusted suicide mortality rates for white males compared to white male farmers in Kentucky, North Carolina, and South Carolina, 1990-1998.^[a]

State	Crude Rate		Age-Adjusted Rate (95% CI)	Rate Difference
	White Males	White Male Farmers	White Male Farmers	White Male Farmer Excess Rate
	Kentucky	31.15	39.24	39.50 (34.3-45.1)
North Carolina	29.53	47.26	48.09 (39.63-57.44)	18.56
South Carolina	32.16	30.48	35.51 (22.47-51.43)	3.35

^[a] Rates are per 100,000 persons per year. Rates for white males use U.S. Census denominator data. Rates for white male farmers use Census of Agriculture data as the denominator. Age-adjusted rates are directly adjusted to the white male population for each state as the referent.

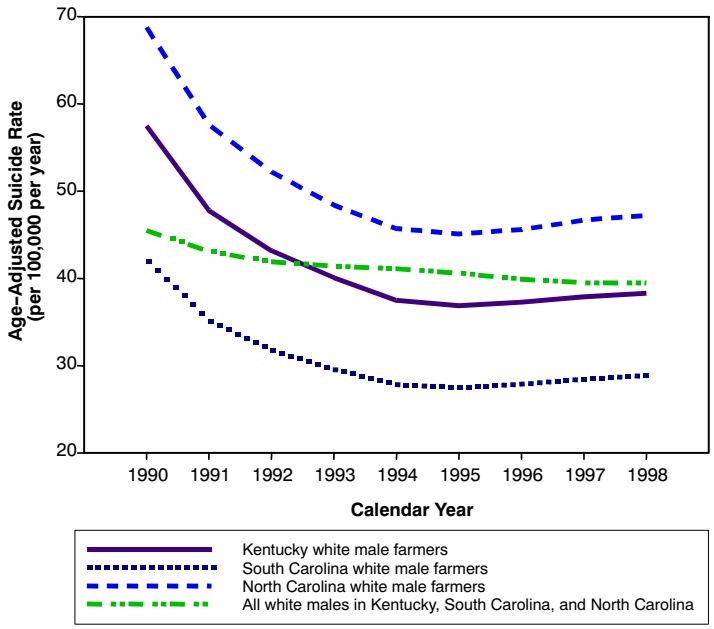


Figure 1. White male farmer suicide rates by state (Kentucky, South Carolina, and North Carolina) in comparison to total white male suicides in the three states, 1990-1998. Rates are age adjusted to the U.S. Census population estimates of all white males in the three states for the time period 1990-1998 and smoothed using a running median approach.

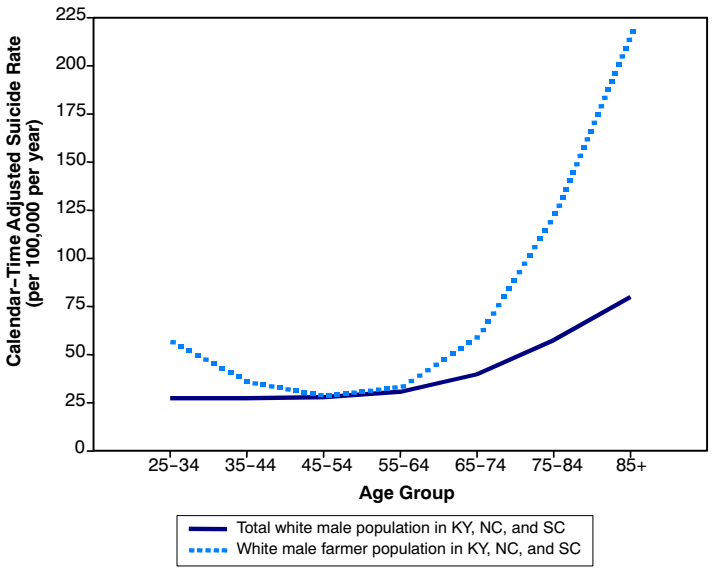


Figure 2. White male farmer suicide rates in comparison to total white male suicide rates in the three states by age group, 1990-1998. Rates are calendar-time adjusted to the U.S. Census population estimates of all white males in the three states for the time period 1990-1998 and smoothed using a running median approach.

Table 4. Poisson regression analysis for white male farmer suicides compared to total white males by age group in Kentucky, North Carolina, and South Carolina, 1990-1998.

Age Group (years)	Kentucky	North Carolina	South Carolina	Total
	IDR ^[a] (95% CI)	IDR (95% CI)	IDR (95% CI)	IDR (95% CI)
25-34	1.97 (1.51-2.56)	2.52 (1.91-3.32)	1.39 (0.97-2.00)	2.07 (1.61-2.67)
35-44	0.99 (0.78-1.26)	1.27 (0.98-1.63)	0.70 (0.50-0.99)	1.04 (0.83-1.31)
45-54	1.00	1.00	1.00	1.00
55-64	0.70 (0.54-0.90)	0.90 (0.69-1.16)	0.50 (0.35-0.70)	0.74 (0.58-0.94)
65-74	1.25 (1.01-1.54)	1.60 (1.29-1.99)	0.88 (0.65-1.21)	1.31 (1.08-1.58)
75-84	1.94 (1.59-2.38)	2.49 (2.02-3.08)	1.37 (1.01-1.88)	2.04 (1.70-2.45)
85+	2.62 (1.96-3.51)	3.36 (.48-4.54)	1.85 (1.29-2.67)	2.67 (2.02-3.54)

^[a] IDR = incidence density ratio (rate ratio), which is calculated from Poisson regression. The Poisson regression model controls for age group, state, an indicator for occupation (farmer vs. all occupations), calendar time (years as a continuous term), and the interactions of occupation by state and occupation by age group. The referent group for age is 45-54 years. The IDRs contrast the rate ratio of farmers compared to total white males in all occupations within the state and age strata of the table. 95% confidence intervals are given for the IDR from the regression. The “total” column provides the summary IDRs for the three states by age group.

The adjusted incidence density ratios (IDRs) from the Poisson regression analysis comparing farmers to the total white male population by age and state are given in table 4. The increased rate of suicide was significantly elevated among farmers age 25-34 years (RR: 2.07; 95% CI: 1.61-2.67) and among those age 75-84 (RR: 2.04; 95% CI: 1.70-2.45) and age 85 years and older (RR: 2.67; 95% CI: 2.02-3.54) in comparison to the total white male population. Middle-aged farmers (35-64 years) generally experienced reduced rates of suicide relative to the referent population. Rate ratios comparing farmer suicide rates to the total white male population rates were consistently higher in North Carolina across all age strata.

Discussion

The age-adjusted rate comparisons between white male farmers and the total white male population indicate that farmer suicide rates were higher than total suicide rates in all three states. The rates were significantly higher in Kentucky and North Carolina, with a rate difference of 18.6 white male farmer suicides per 100,000 persons per year in North Carolina compared to total white male suicides. While North Carolina had the highest farmer suicide mortality rate of the three states in the study, the largest number of farmer suicide cases was in Kentucky ($N = 312$ farmer suicides over the nine-year period). The findings from this study indicate that the age-adjusted farmer suicide rates are 4 to 6 times higher in these southern states in comparison to the age-adjusted farm suicide rates among farmers in Ontario, Canada (Pickett et al., 1993). Pickett et al. (1999) indicated that farmers did not have elevated suicide rates in comparison to the general population. Stallones (1990) reported an average annual suicide rate for Kentucky white male

farmers (1979-1985) of 42.2 deaths per 100,000, which is comparable to the 39.5 white male farmer suicide rate (1990-1998) reported in this study. Although there are differences in the methodology used for the calculation of the suicide rates, primarily due to the source of the denominator data for the earlier period of time in the Stallones study, this suggests that since the early 1980s, there has not been a substantive decline in the rates for male farmer suicides in Kentucky (Stallones, 1990).

The finding that older white male farmers (>65 years) are at an increased risk of suicide in comparison to the total white male population was apparent in our study and is consistent with other published work addressing farmer suicides (Pickett et al., 1993; Stallones, 1990). Male farmers in the 75-84 age group were twice as likely to die from suicide in comparison to the total white male population, and male farmers age 85 years and older were 2.6 times (RR: 2.67; 95% CI: 2.02-3.54) more likely to die from suicide. Factors accounting for the elevated suicide rates among the oldest farmers cannot be assessed from mortality data. However, authors have speculated that increased risk may be related to chronic pain, depression, financial problems, disrupted marital status (e.g., loss of a spouse), or other stressful life events. It has been suggested that farmers may be more likely to present with physical problems when they are depressed, given the “stigma” associated with mental illness, thereby preventing appropriate treatment of their depression (Booth et al., 2000).

Suicide rates for white male farmers in North Carolina were significantly higher than either Kentucky or South Carolina after adjustment in the Poisson regression analysis. The elevated rate of white male farmer suicides in North Carolina requires further explanation and is likely associated with a complex interplay of social, economic, cultural, and temporal factors. One explanation for this elevation may be related to a methodological issue in the calculation of the rates. The proportion of full-time farmers is higher in North Carolina than in Kentucky and South Carolina. Consequently, the occupational code on the death certificate may be a more accurate reflection of farm employment in populations with a higher proportion of full-time farmers. That is, persons who certify the death may be more likely to write the full-time occupation than the part-time occupation. The temporal trend indicated that the North Carolina male farmer suicide rate declined in the early 1990s and stabilized. This may reflect, in part, complex stressors associated with the “farm crisis” of the mid-1980s. Schulman and Armstrong (1989) reported on the difficulties of the late 1980s for farm operators in North Carolina, including the drought year of 1986 and the complex changes related to federal programs supporting tobacco production. The trend patterns were similar in the three states, although the rates were highest in North Carolina in 1990. These data demonstrate the importance of examining regional patterns in farmer suicide mortality rates. Commodity distributions, agricultural practices including the use of pesticides, financial factors, and weather patterns vary by state. To date, little attention has been given to collecting individual-level data on the potential risk factors for farmer suicides using cohort or case control designs.

Firearms remain the most common method of committing suicide among farmers (Booth et al., 2000; Hawton et al., 1998; Stallones, 1990). For male farmers in the three southern states in this study, the primary mechanism for committing suicide was the use of a firearm (86% of deaths), followed by hanging (7%). There is ecological evidence suggesting that a restriction in use of guns through registration, etc., may lead to a decline in firearm death rates (Hawton et al., 1998). During the study period examined by Hawton et al. (1998), there was a reduction in firearm death rates, particularly after 1989 when there was national legislation on firearm ownership, registration, and storage. Since farmers, as an occupational group, are more likely to have access to firearms, the use of a firearm, as opposed to a less lethal method (e.g., hanging) may account for their

increased suicide mortality. A case control study of farmer suicides by Booth et al. (2000) confirmed that farmers were more likely to use firearms to kill themselves compared with controls (nonfarmers). It has been suggested that some consideration be given to removing firearms from the household from persons with depression and suicidal behaviors (Booth et al., 2000).

Strengths and Limitations

Given the small numbers of suicides among minority and female farmers in this study, we were unable to calculate stable rates for these groups, and inferences from our data may not extend to these groups of farmers. The use of farmer-specific population estimates from the Census of Agriculture for the time period of study was intended to improve our estimates of the denominator for rate calculations. This estimation is likely most accurate in areas where there is a higher proportion of full-time farm operators who would be most likely contacted by the Census of Agriculture in estimating the full-time farmer population and have their primary occupation coded as “farmer” on their death certificates. Farmer deaths due to suicide may be classified by coroners as deaths due to unintentional injuries, as those related to tractor rollovers or other farm-related, unintentional deaths. There is anecdotal evidence to suggest that misclassification may occur in some circumstances in order to obtain life insurance benefits or to reduce the stigma associated with suicide as the cause of death. However, several studies have generally concluded that there is a high level of specificity for the coding of suicide deaths, with perhaps 10% being coded to other categories of death (Mohler and Earls, 2001; Moyer et al., 1989). This is one limitation of using only the primary cause of death in the analysis.

Despite the observed elevated rate of suicides among farmers, a determination of whether this increased risk is due to occupational factors cannot be assessed from the analysis of mortality statistics. Most farmers live in a rural environment, which independently may increase risk. Consequently, the effect reported for farmers may not necessarily be a reflection of occupational factors, per se, as much as a consequence of rural life in general. The choice of an appropriate comparison group is an important issue in understanding patterns of suicide among farmers. It may not be appropriate to compare the farmer suicide rates to the suicide rates in the state as a whole, but rather to the rural component of the state’s population.

Implications and Interpretation

The results of this study confirm the increased risk of suicide mortality among white male farmers in comparison to the total white male population in three southern states. The increased risk of suicide death is significantly elevated among white male farmers age 65 years and older. The use of a firearm is the primary mechanism of death for the majority of the cases. White male farmer suicide rates vary substantially by state and over time. The elevated rate of white male farmer suicides in North Carolina requires further explanation and is likely associated with complex social and individual level risk factors. It is clearly evident that interventions in the prevention of suicide need to be directed to older male farmers, who consistently have higher suicide rates than similar males in other occupations. These interventions need to address and target farmers’ access to firearms as the primary mechanism of suicide. It is regrettable that there has been little change in the rates of farm-related suicides in Kentucky since the early publication by Stallones (1990) for the period 1979-1985. Mental health services for rural farmers have been limited, and from a public health perspective, interventions regarding this issue have been few (Rosmann, 2005).

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References

- Abramson, J. H., and P. M. Gahlinger. 2001. *Computer Programs for Epidemiologists: PEPI Version 4.0*. Salt Lake City, Utah: Sagebrush Press.
- Allen, R., and G. Harris. 2005. *What We Know About the Demographics of U.S. Farm Operators*. Washington, D.C.: USDA National Agricultural Statistics Service.
- Booth, N., M. Briscoe, and R. Powell. 2000. Suicide in the farming community: Methods used and contact with health services. *Occup. Environ. Med.* 57(9): 642-644.
- Burnley, I. H. 1994. Differential and spatial aspects of suicide mortality in New South Wales and Sydney, 1980 to 1991. *Australian J. Public Health* 18(3): 293-304.
- CDC. 1997. Regional variations in suicide rates: United States, 1990-1994. *MMWR* 46(34): 789-793.
- Frank, A. L., R. McKnight, S. R. Kirkhorn, and P. Gunderson. 2004. Issues of agricultural safety and health. *Ann. Rev. Public Health* 25: 225-245.
- Gray, J. T. 2000. *Green Blood, Red Tears*. Lexington, Ky.: Kentucky Educational Television, KET Fund for Independent Production.
- Hawton, K., J. Fagg, S. Simkin, L. Harriss, and A. Malmberg. 1998. Methods used for suicide by farmers in England and Wales: The contribution of availability and its relevance to prevention. *British J. Psychiatry* 173(Oct.): 320-324.
- Kaplan, M. S., and O. Geling. 1998. Firearm suicides and homicides in the United States: Regional variations and patterns of gun ownership. *Social Sci. and Med.* 46(9): 1227-1233.
- Kposowa, A. J. 1999. Suicide mortality in the United States: Differentials by industrial and occupational groups. *American J. Ind. Med.* 36(6): 645-652.
- Liu, T., and J. W. Waterbor. 1994. Comparison of suicide rates among industrial groups. *American J. Ind. Med.* 25(2): 197-203.
- Malmberg, A., K. Hawton, and S. Simkin. 1997. A study of suicide in farmers in England and Wales. *J. Psychosomatic Res.* 43(1): 107-111.
- McCurdy, S. A., and D. J. Carroll. 2000. Agricultural injury. *American J. Ind. Med.* 38(4): 463-480.
- Mohler, B., and F. Earls. 2001. Trends in adolescent suicide: Misclassification bias? *American J. Public Health* 91(1): 150-153.
- NIOSH. 2004. *Worker Health Chartbook, 2004*. DHHS (NIOSH) Publication No. 2004-146. Cincinnati, Ohio: NIOSH. Available at: www.cdc.gov/niosh/docs/2004-146/pdfs/2004-146.pdf.
- Moyer, L. A., C. A. Boyle, and D. A. Pollock. 1989. Validity of death certificates for injury-related causes of death. *American J. Epidemiology* 130: 1024-1032.
- Page, A. N., and L. J. Fragar. 2002. Suicide in Australian farming, 1988-1997. *Australian and New Zealand J. Psychiatry* 36(1): 81-85.
- Pickett, W., J. R. Davidson, and R. J. Brison. 1993. Suicides on Ontario farms. *Canadian J. Public Health* 84(4): 226-230.
- Pickett, W., W. D. King, and T. Faelker. 1999. Suicides among Canadian farm operators. *Chronic Diseases in Canada* 20(3): 105-110.

- Pylka, K. P., and P. D. Gunderson. 1992. An epidemiologic study of suicide among farmers and its clinical implications. *Marshfield Clinical Bulletin* 26. Marshfield, Wisc.: Marshfield Clinic.
- Reed, D. B. 2004. The risky business of production agriculture: Health and safety for farm workers. *AAOHN J.* 52(9):401-409.
- Rosmann, M. R. 2005. Sowing the seeds of hope: Providing regional behavioral health supports to the agricultural population. *J. Agric. Safety and Health* 11(4): 431-439.
- SAS. 1999. SAS version 8.0. Cary, N.C.: SAS Institute, Inc.
- Saunderson, T., R. Haynes, and I. H. Langford. 1998. Urban-rural variations in suicides and undetermined deaths in England and Wales. *J. Public Health Med.* 20(3): 261-267.
- Schulman, M. D., and P. Armstrong. 1989. The farm crisis: An analysis of social psychological distress among North Carolina farm operators. *American J. Comm. Psychology* 17(4): 423-441.
- Singh, G. K., and M. Siahpush. 2002. Increasing rural-urban gradients in U.S. suicide mortality, 1970-1997. *American J. Public Health* 92(7): 1161-1167.
- SPSS. 2001. SigmaPlot 2002 for Windows version 8.0. Chicago, Ill.: SPSS, Inc.
- Stallones, L. 1990. Suicide mortality among Kentucky farmers, 1979-1985. *Suicide Life Threat. Behav.* 20(2): 156-163.
- Stallones, L., and M. Cook. 1992. Suicide rates in Colorado 1980-1989: Metropolitan, non-metropolitan, and farm comparisons. *J. Rural Health* 8(2): 139-142.
- Theilin, A. 1991. Morbidity in Swedish farmers, 1978-1983, according to national hospital records. *Social Sci. and Med.* 32(3): 305-309.
- USDA. Census of agriculture 1992 and 1997. Washington, D.C.: USDA National Agricultural Statistics Service. Available at: www.nass.usda.gov/Census_of_Agriculture/Documentation/index.asp. Accessed 20 March 2007.
- U.S. DHHS. 1999. *Industry and Occupational Coding for Death Certificates: Instruction Manual*, part 19. Washington, D.C.: U.S. Department of Health and Human Services.
- Zwerling, C., L. F. Burmeister, and C. M. Jensen. 1995. Injury mortality among Iowa farmers, 1980-1988: Comparison of PMR and SMR approaches. *American J. Epidemiology* 141(9): 878-882.