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Abstract

Overall individual health has been critically improved over the last century in the United States. However, among the leading causes of death, only suicide rates show a significant increase in recent decades and the increases have been even greater among females. This study is designed to better understand adult suicide mortality risk by sex and age groups using data from the National Health Interview Surveys linked to mortality information from the National Death Index (1986-2006). Our results from Cox proportional hazard models confirm that the social patterns in suicide mortality differ by sex: strong associations of education, marriage and bed disability days for males vs. weak or little associations for females. We also found variations in the associations across age groups. The findings provide useful insights for prevention to reduce adult suicide mortality.

Word count: 133

INTRODUCTION

Overall individual health has been critically improved over the last century in the United States. The life expectancy has increased for most people and death rates for top leading causes have also continuously decreased. However, among the leading causes of death, only suicide rates show a significant increase in recent decades. Further, while suicide mortality risk is much higher among males, the increases have been even greater among females (Heron. 2012; Kochanek et al. 2011). For example, suicide rates were higher among females especially those aged 45 to 54 having rise over 42% since 1999. In comparison, the rates among females ages 25 to 34 and 35 to 44 years increased 11% and 16%, respectively (Heron. 2012).

Suicide is mainly caused by social pathologies. In other words, unlike other many causes of death, suicide is not necessarily directly resulted from diseases or degenerative physical functioning. Not surprisingly, suicide has received substantial attention in a number of studies in social science, including one of the classic works by Durkheim in 1897 (1951). However, much work seems to focus on social relationships to suicide at the aggregate levels and only a handful of studies looked at suicide mortality risk using individual-level data (e.g. Breault. 1986; Denney, Rogers, Krueger, and Wadsworth. 2009; Denney. 2010; Kposowa, 2000; Kposowa, Breault and Singh. 1995; Stack. 1990; Stack and Wasserman 1993).

This study is designed to better understand adult suicide mortality risk by sex and age groups using data from the National Health Interview Surveys (NHIS) linked to mortality information from the National Death Index. More specifically, we analyze the data in two steps. First, we estimate adult suicide mortality risk using a series of nested

models to evaluate the roles of various social factors separately by sex. To begin with, we examine suicide mortality differentials by educational attainment with demographics (i.e. race, age and geographic region) adjusted. Then, we progressively add marital status, family size, economic conditions, bed disability days and body mass index to subsequent models. In the second step, we perform the full models separately by three age groups: those of ages 18 to 44, ages 45 to 64, and ages 65 to 84. Utilizing various social factors as well as demographic information, we aim to provide useful insights into suicide mortality by sex and age groups who might be exposed to different social roles and relations.

METHODS

Data

   We use data from the National Health Interview Study Linked Mortality File (NHIS-LMF). NHIS-LMF is based on multiple years of the NHIS (1986-2004) with death records in the National Death Index (NDI) through December 31, 2006. The NHIS is a cross-sectional survey that has been annually conducted to collect various information about health, demographics and social attainments among non-institutionalized population in the United States since 1957. The NHIS-LMF links adult respondents in the NHIS to death records in the NDI using a probabilistic matching algorithm (Lochner et al. 2008; National Center for Health Statistics 2009). Using the data, we select adult respondents aged 18 to 84 as the NHIS top-coded age at 85 from the 1997 survey. After excluding those who are missing on our primary variables, such as race, education, marital status and self-rated health, our analytical sample includes

1,119,232 cases and among those, suicide deaths are 1,719 (1,364 males and 355

females).

Measures

The dependent variable is suicide mortality status. It is based on the final vital

status of the respondents during the follow-up period. The status was determined by

NCHS based on probabilistic matches of survey participants' NHIS records to the

National Death Index (NDI) records. Among those who are 'assumed deceased,' suicide

mortality is identified if the death was caused by 'intentional self-harm' in the 10th

revision of International Statistical Classification of Diseases (Codes X60-X84). For

race/ethnicity, it is dichotomously coded into two categories: non-Hispanic white vs.

others.

We also include the following sociodemographic information as control variables

in the analysis: age; sex; region; marital status; family size; educational attainment;

poverty status; and employment status. Age is measured in years ranging 18 to 84. Sex is

dichotomously coded (i.e. '0' for female and '1' for male). Region is coded into

'Northeast,' 'Mid-west,' 'West,' and 'South.' Marital status is specified as 'married,'

'widowed,' 'divorced/separated', or 'never married.' Family size refers to number of

family in household. It is top coded at six. Educational attainment has four categories:

'less than high school,' 'high school,' 'some college,' and 'college or more.' Poverty

status indicates whether or not respondents are below the poverty threshold at the time of

the survey (i.e. '0' for those who are above the poverty threshold and '1' for those who

are below the poverty threshold). We also include another variable for those who are

missing on poverty status. For employment status, we categorize respondents into either 'employed' or 'unemployed.'

Additional variables for bed disability days in the past year and body mass index are included in the analysis as proxies for chronic health condition(s) and health behaviors. 'Bed disability days' measures the number of days during the past 12 months that illness or injury kept the individual in bed for more than half the day, including days while hospitalized. We categorize it into four groups: 0 days; 1-7 days; 8-30 days; and 30 or more days. 'Body Mass Index (BMI)' is calculated based on self-reported height and weight. This continuous measure is also recoded for four categories: low weight (<18.5); normal weight (18.5-24.9); overweight (25-29.9); and obese (≥30). Lastly, information about 'self-rated health' is included. 'Self-rated health' is a measurement of an individual's general health (as self-reported by the person in question or evaluated by a family member) on a question about their overall health and the response categories are: poor, fair, good, very good, and excellent. They are coded 1 to 5, with higher values indicating higher ratings of health.

All of the statistics in this study were weighted to adjust for the complex sample design and non-response of the NHIS-LMF unless otherwise indicated.

RESULTS

Descriptive Statistics

Table 1 describes the sample characteristics.

(Table 1 about here)

As shown in the table, one percent of the sample accounts for the suicide death. Because our analysis is limited to adults ages 18 to 84, the proportion of non-Hispanic whites (i.e. 75.6%) is slightly higher compared to the national population. As expected, there are more females (52.5%) than males (47.5%). More than half of the sample is in the younger age group (i.e. ages 18 to 44) and almost 30% and 10% of them are in the mid age and the older age groups, respectively. A larger proportion of the sample resides in South (i.e. 35%) than in other regions. In our sample, over 60% percent are married, and about 20% are never married. The divorced or separated account for about 10% and the remaining small proportion is for the widowed (4%). Regarding the socioeconomic indicators, more than half of the sample has high school or some college education. Almost nine percent live below the poverty threshold and over 70% are employed. The table also shows that, while 43.8% of the sample did not have any bed disability days in the preceding year, more than 30% experienced disabled in bed due to illness or injury more than one day.

Distribution of the suicide mortality by sex and the age groups is presented in Table 2.

(Table 2 about here)

As shown, suicide mortality is more than four times higher among males than females (i.e. 0.247 vs. 0.055). Among both males and females, age pattern is also found. While manifested more clearly among males, suicide death rates are higher among older age groups.

Empirical Findings from the Proportional Hazard Models

(Table 3 about here)

Our results confirm findings from previous studies that males and females are exposed to different suicide mortality risks by several social conditions. For example, while those with higher education have lower risk of suicide mortality among males, even after controlling for other factors, such as economic conditions and health related measures; education does not appear to contribute to suicide mortality risk among females. In addition, males seem more vulnerable to suicide mortality risk if they are not married. However, only divorced/separated females experience higher suicide mortality risk than married. Both widowed and never married do not appear to be disadvantaged in terms of suicide mortality risk.

We also found variations in the association between these social factors and suicide mortality by age groups.

(Table 4 about here)

The results from the sex and age group stratified models show that getting more education reduces suicide mortality risk among males, especially the younger and older adults (not the mid-aged). However, the opposite pattern was found among females. Although lower educated females have higher suicide mortality risk in the younger age group (i.e. ages 18 to 44), this relationship was not linear. But, more interestingly, among those who aged 45 to 64, higher educated females have a higher suicide mortality risk.

The effects of marital status also vary by age groups. Never married males appear to have higher suicide mortality risk in the younger age group, but among the mid-aged males, the widowed and divorced/separated males seem more vulnerable. Among females, however, the divorced/separated show higher suicide mortality risk (with an exception among the mid-aged females).

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With respect to the health-related conditions, our findings are also different for males and females. For example, males who experienced illness or injury and therefore stayed in bed show higher suicide mortality risk, and the longer they spent in bed, the higher risk they exposed especially in the younger age group. Among the mid-aged males, those who spent more than a week but less than a month show higher risk for suicide. On the other hand, among females in the younger and mid-aged groups, those who had eight to thirty bed disability days show significantly higher suicide mortality risk. The coefficients of BMI variables are different from what we expected. Those who are overweight and obese have lower suicide mortality risk than those with normal weight for both males and females. Self-rated health shows consistent and significant associations with suicide mortality risk across the age groups by sex, indicating that higher ratings of self-rated health predict lower risks of suicide mortality.

Despite a long interest in suicide among social scientists, our understanding about associations between social factors and suicide mortality risk is limited. In this study, we provide estimates for sex and age differentials in suicide mortality risk using a nationally representative sample of the most recent available individual mortality data. Future research should investigate the roles of social support, health behaviors (and/or risk taking behaviors), and specific chronic conditions in health and mortality to provide more specific insights for prevention to reduce suicide mortality.

Table 1. Sample Characteristics										
	All				Male				Female		
Variable	Proportion		Max.	Min.	Proportion		Max.	Min.	Proportion		Max.	Min.
Mortality Status												
Alive	0.999		0.000	1.000	0.998		0.000	1.000	0.999		0.000	1.000
Suicide Mortality	0.001		0.000	1.000	0.002		0.000	1.000	0.001		0.000	1.000
Race												
Non-Hispanic white	0.756		0.000	1.000	0.762		0.000	1.000	0.751		0.000	1.000
Others	0.244		0.000	1.000	0.238		0.000	1.000	0.249		0.000	1.000
Sex												
Female	0.525		0.000	1.000	0.000		0.000	0.000	1.000		1.000	1.000
Male	0.475		0.000	1.000	1.000		1.000	1.000	0.000		0.000	0.000
Age groups												
Age 18 to 44	0.621		0.000	1.000	0.639		0.000	1.000	0.604		0.000	1.000
Age 45 to 64	0.284		0.000	1.000	0.281		0.000	1.000	0.286		0.000	1.000
Age 65 to 84	0.096		0.000	1.000	0.079		0.000	1.000	0.110		0.000	1.000
Region												
Northeast	0.201		0.000	1.000	0.199		0.000	1.000	0.202		0.000	1.000
Mid-West	0.244		0.000	1.000	0.246		0.000	1.000	0.243		0.000	1.000
South	0.352		0.000	1.000	0.348		0.000	1.000	0.355		0.000	1.000
West	0.203		0.000	1.000	0.207		0.000	1.000	0.200		0.000	1.000
Marital Status												
Married	0.631		0.000	1.000	0.650		0.000	1.000	0.613		0.000	1.000
Widowed	0.040		0.000	1.000	0.013		0.000	1.000	0.066		0.000	1.000
Divorced/Separated	0.107		0.000	1.000	0.086		0.000	1.000	0.126		0.000	1.000
Never married	0.222		0.000	1.000	0.251		0.000	1.000	0.195		0.000	1.000
Education												
Less than high school	0.156		0.000	1.000	0.158		0.000	1.000	0.154		0.000	1.000
High school	0.359		0.000	1.000	0.347		0.000	1.000	0.371		0.000	1.000
Some college	0.256		0.000	1.000	0.247		0.000	1.000	0.264		0.000	1.000
College or higher	0.229		0.000	1.000	0.249		0.000	1.000	0.210		0.000	1.000
Poverty status												
Above poverty	0.769		0.000	1.000	0.788		0.000	1.000	0.753		0.000	1.000
Below poverty	0.086		0.000	1.000	0.072		0.000	1.000	0.099		0.000	1.000
Missing	0.144		0.000	1.000	0.140		0.000	1.000	0.148		0.000	1.000
Employment status												
Employed	0.708		0.000	1.000	0.798		0.000	1.000	0.626		0.000	1.000
Unemployed	0.292		0.000	1.000	0.202		0.000	1.000	0.374		0.000	1.000
Bed disability days in the past year												
0 Days	0.438		0.000	1.000	0.464		0.000	1.000	0.414		0.000	1.000
1-7 Days	0.249		0.000	1.000	0.224		0.000	1.000	0.271		0.000	1.000
8-30 Days	0.047		0.000	1.000	0.033		0.000	1.000	0.060		0.000	1.000
30+ Days	0.017		0.000	1.000	0.013		0.000	1.000	0.021		0.000	1.000
Missing	0.250		0.000	1.000	0.267		0.000	1.000	0.235		0.000	1.000
Body Mass Index												
Low weight (<18.5)	0.018		0.000	1.000	0.006		0.000	1.000	0.029		0.000	1.000
Normal weight (18.5-24.9)	0.349		0.000	1.000	0.289		0.000	1.000	0.404		0.000	1.000
Overweight (25-29.9)	0.243		0.000	1.000	0.310		0.000	1.000	0.183		0.000	1.000
Obese (≥ 30)	0.116		0.000	1.000	0.113		0.000	1.000	0.118		0.000	1.000
Missing	0.274		0.000	1.000	0.283		0.000	1.000	0.265		0.000	1.000
	Mean	Std. Dev.			Mean	Std. Dev.			Mean	Std. Dev.		
Age	41.277	15.577	18	84	40.462	15.240	18	84	42.015	15.825	18	84
Age squared	1942.690	1440.410	324	7056	1859.680	1382.430	324	7056	2017.890	1484.500	324	7056
Family size	2.959	1.416	1.000	6.000	2.978	1.442	1.000	6.000	2.941	1.392	1.000	6.000
Self-rated health	3.911	1.029	1.000	5.000	3.988	1.025	1.000	5.000	3.842	1.028	1.000	5.000
Mortality follow-up	10.749	5.493	0.125	20.875	10.695	5.564	0.125	20.875	10.798	5.430	0.125	20.875
N	1,119,232				517,484				601,748			

Table 2. Suicide by Sex and Age Groups									
		Male					Female		
			Unweighted	Weighted				Unweighted	Weighted
	All	Alive	Death (n)	Death Rate (%)	All	Alive		Death (n)	Death Rate (%)
age 18 to 44	331,709	330,942	767	0.219	368,338	368,127		211	0.054
age 45 to 64	146,384	146,044	340	0.225	170,508	170,414		94	0.052
age 65 to 84	39,391	39,134	257	0.550	62,902	62,852		50	0.073
Total	517,484	516,120	1,364	0.247	601,748	601,393		355	0.055

Table 3. Proportional Hazard Models for Suicide Mortality Risk by Sex

| | Male | | | | | | | | | | Female | | | | | | | | | |
| | Model 1 | | Model 2 | | Model 3 | | Model 4 | | Model 5 | | Model 1 | | Model 2 | | Model 3 | | Model 4 | | Model 5 | |
Variable	Coeff.	HR	Coeff.	HR	Coeff.	HR	Coeff.	HR	Coeff.	HR	Coeff.	HR	Coeff.	HR	Coeff.	HR	Coeff.	HR	Coeff.	HR
Race (Others)																				
Non-Hispanic white	0.87 ***	2.40	0.90 ***	2.46	0.85 ***	2.33	0.86 +	2.36	0.85 ***	2.34	0.92 ***	2.51	0.99 ***	2.68	0.90 ***	2.45	0.91 ***	2.49	0.91 ***	2.47
Age	-0.05 ***	0.95	-0.03 **	0.97	-0.04 ***	0.96	-0.02 +	0.98	-0.03 **	0.97	0.00	1.00	0.00	1.00	-0.01	0.99	0.02	1.02	0.01	1.01
Age squared	0.00 ***	1.00	0.00 ***	1.00	0.00 ***	1.00	0.00 **	1.00	0.00 ***	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00
Region (Northeast)																				
Mid-West	0.13	1.14	0.14	1.15	0.13	1.14	0.14	1.15	0.13	1.14	0.46 *	1.59	0.47 *	1.59	0.45 *	1.57	0.48 **	1.61	0.48 **	1.62
South	0.48 ***	1.61	0.49 ***	1.63	0.47 ***	1.59	0.47 ***	1.59	0.43 ***	1.54	0.49 **	1.63	0.49 **	1.63	0.46 **	1.59	0.47 **	1.59	0.42 *	1.53
West	0.49 ***	1.62	0.49 ***	1.63	0.47 ***	1.60	0.46 ***	1.59	0.44 ***	1.55	0.70 ***	2.02	0.69 ***	2.00	0.68 ***	1.97	0.67 ***	1.95	0.63 ***	1.87
Education (College or higher)																				
Less than high school	0.76 ***	2.13	0.73 ***	2.07	0.78 ***	2.18	0.71 ***	2.04	0.52 ***	1.68	0.06	1.07	0.04	1.04	0.13	1.14	-0.05	0.95	-0.30	0.74
High school	0.46 ***	1.59	0.45 ***	1.57	0.47 ***	1.61	0.45 ***	1.56	0.35 ***	1.42	0.13	1.14	0.12	1.13	0.18	1.19	0.10	1.11	-0.02	0.98
Some college	0.23 *	1.26	0.20 *	1.23	0.21 *	1.24	0.18 *	1.20	0.14	1.15	0.21	1.23	0.18	1.19	0.21	1.23	0.17	1.18	0.08	1.09
Marital status (Married)																				
Widowed			0.66 ***	1.93	0.55 ***	1.74	0.55 ***	1.73	0.51 ***	1.66			0.09	1.09	-0.04	0.96	0.01	1.01	0.01	1.01
Divorced/Separated			0.63 ***	1.87	0.45 ***	1.58	0.43 ***	1.53	0.36 ***	1.43			0.79 ***	2.20	0.63 ***	1.88	0.75 ***	2.12	0.65 ***	1.92
Never married			0.39 ***	1.48	0.26 **	1.29	0.19 *	1.21	0.15 +	1.17			0.30 +	1.35	0.12	1.12	0.18	1.20	0.19	1.21
Family size					-0.12 ***	0.89	-0.12 ***	0.88	-0.11 ***	0.89					-0.17 ***	0.84	-0.21 ***	0.81	-0.19 ***	0.83
Poverty status (Above poverty)																				
Below poverty							-0.06	0.94	-0.20 +	0.82							-0.23	0.79	-0.39 +	0.67
Missing							-0.13	0.88	-0.11	0.90							0.02	1.02	-0.03	0.97
Employment (Employed)																				
Unemployed							0.49 ***	1.64	0.31 ***	1.36							0.88 ***	2.41	0.69 ***	1.99
Bed disability days in the past year (0 days)																				
1-7 Days									0.06	1.06									-0.06	0.95
8-30 Days									0.59 ***	1.81									0.28	1.32
30+ Days									0.60 ***	1.82									0.98 ***	2.66
Missing									0.45 *	1.57									0.32	1.38
Body Mass Index (Normal weight)																				
Lower weight									-0.27	0.76									0.18	1.20
Overweight									-0.37 ***	0.69									-0.57 ***	0.57
Obese									-0.32 ***	0.72									-0.82 ***	0.44
Missing									-0.88 ***	0.42									-0.46	0.63
Self-rated health									-0.24 ***	0.79									-0.36 ***	0.70
-2LL	33501.972		33429.361		33403.699		33355.521		33157.799		8436.176		8408.073		8396.152		8347.539		8239.544	

Note: The values in parentheses are reference categories. *** p<.001; ** p<.01; * p<.05; + p<.10.

Table 4. Proportional Hazard Models for Suicide Mortality Risk by Sex and Age Groups												
	Male						Female					
	Age 18-44		Age 45-64		Age 65-84		Age 18-44		Age 45-64		Age 65-84	
	Coefficient	HR	Coefficient	HR	Coefficient	HR	Coefficient	HR	Coefficient	HR	Coefficient	HR
Race (Others)												
Non-Hispanic white	0.74 ***	2.10	1.02 ***	2.78	1.03 ***	2.79	0.75 ***	2.11	1.54 **	4.66	1.29 +	3.63
Age	0.02 **	1.02	0.00	1.00	0.06 ***	1.06	0.03 *	1.03	-0.03	0.97	0.06 *	1.07
Region (Northeast)												
Mid-West	0.12	1.13	0.08	1.09	0.18	1.20	0.52 *	1.68	0.46	1.59	0.29	1.34
South	0.29 **	1.34	0.48 **	1.62	0.77 ***	2.15	0.37	1.45	0.58 +	1.78	0.23	1.26
West	0.24 *	1.28	0.58 **	1.78	0.79 ***	2.20	0.60 *	1.83	0.35	1.41	0.99 *	2.68
Education (College or higher)												
Less than high school	0.82 ***	2.28	0.04	1.04	0.69 ***	2.00	0.56 +	1.75	-1.33 **	0.27	-0.24	0.79
High school	0.59 ***	1.80	0.00	1.00	0.44 *	1.55	0.52 *	1.69	-0.84 **	0.43	0.51	1.66
Some college	0.40 **	1.49	-0.24	0.78	0.05	1.05	0.69 **	2.00	-0.81 **	0.45	0.19	1.21
Marital status (Married)												
Widowed	-0.40	0.67	0.71 *	2.03	0.14	1.15	0.34	1.40	0.01	1.01	-0.60	0.55
Divorced/Separated	0.10	1.11	0.55 ***	1.73	0.15	1.16	0.61 **	1.84	-0.01	0.99	1.00 *	2.71
Never married	0.24 *	1.28	0.32	1.38	-0.51	0.60	0.26	1.29	0.26	1.30	-13.69	0.00
Family size	-0.07 **	0.93	-0.29 ***	0.75	-0.32 *	0.73	-0.17 **	0.84	-0.55 ***	0.58	-0.69 +	0.50
Poverty status (Above poverty)												
Below poverty	0.06	1.07	-0.61 *	0.54	-0.76 +	0.47	-0.39	0.68	-0.34	0.71	-1.01	0.36
Missing	0.05	1.05	-0.08	0.93	-0.49 **	0.61	0.11	1.12	-0.12	0.88	-0.49	0.61
Employment (Employed)												
Unemployed	0.08	1.09	0.41 **	1.51	0.77 ***	2.16	0.64 ***	1.91	0.89 ***	2.44	0.44	1.55
Bed disability days in the past year (0 days)												
1-7 Days	0.24 **	1.27	-0.19	0.82	-0.42 +	0.66	-0.13	0.88	0.23	1.26	-0.19	0.83
8-30 Days	0.71 ***	2.03	0.56 **	1.76	0.32	1.38	0.12	1.13	0.18	1.19	0.80 +	2.22
30+ Days	0.92 ***	2.50	0.35	1.42	0.21	1.24	0.86 **	2.37	1.50 ***	4.46	0.43	1.54
Missing	0.16	1.17	0.60 +	1.83	0.95 *	2.60	0.49	1.64	0.19	1.20	0.50	1.65
Body Mass Index (Normal weight)												
Lower weight	-0.52	0.60	-0.37	0.69	0.58	1.79	0.19	1.21	0.42	1.52	-0.24	0.79
Overweight	-0.31 ***	0.74	-0.55 ***	0.58	-0.37 *	0.69	-0.68 **	0.51	-0.33	0.72	-0.59 +	0.55
Obese	-0.32 *	0.73	-0.44 **	0.64	-0.20	0.82	-0.67 *	0.51	-0.82 *	0.44	-1.26 *	0.28
Missing	-0.38	0.68	-1.11 **	0.33	-1.85 ***	0.16	-0.73	0.48	0.19	1.21	-1.14	0.32
Self-rated health	-0.14 ***	0.87	-0.38 ***	0.68	-0.29 ***	0.75	-0.42 ***	0.66	-0.11	0.90	-0.65 ***	0.52
-2LL	18346.141		7504.347		4572.879		4629.272		1946.339		943.664	

Note: The values in parentheses are reference categories. ***$p<.001$; **$p<.01$; *$p<.05$; +$p<.10$.

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