AN ABSTRACT OF THE THESIS OF

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Title: Suicide and Marital Status: An Empirical Study of 2017

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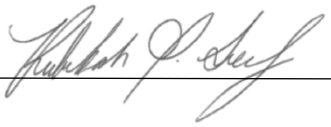
Abstract approved: 

This paper examines the impact of marital status on the likelihood of committing suicide in the 21st Century. This study utilizes the 2017 Multiple Cause of Death mortality data from the National Vital Statistics System of the National Center for Health Statistics, which lends itself to robust probit regression analysis. Controlling for observable characteristics of the deceased (i.e., age group, education, gender, and race/ethnicity), the findings indicate that singles have a relatively lower probability of committing suicide than married individuals, while those who are divorced or widowed are at higher risk. This study also finds the surprising result that education may be negatively correlated with suicide risk. Overall, the findings in this study suggest that, once married, remaining in that marriage may be a protective factor against suicide, which suggests that the findings from previous studies still hold in 2017 despite the changing nature of marriage in the present era.

Keywords: Probit, Suicide, Education, Divorce, Gender, Race, Widow, Marriage

SUICIDE AND MARITAL STATUS:

AN EMPIRICAL STUDY OF 2017

A Thesis

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Master of Science

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TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

1. INTRODUCTION

We are in an era where both the divorce rate and the suicide rate are undergoing significant changes. Unquestionably, changes in marital status have an impact on people's lives. Marital status–as a demographic characteristic–has physiological, social, economic, and legal significance. It is also among the important factors of population dynamics. Thus, exploring the relationship between changes in marital status and suicide rate is of particular interest. Ever since French sociologist Émile Durkheim mentioned in Suicide: A Study in Sociology in 1897 that marriage and family status and suicide rate are related, people have begun to study the subject of marriage and death risk (1966). People use relative mortality ratio (RMR) to observe the differences and changes in mortality under different marital status. The RMR of marital status and mortality can be calculated by regressing an indicator for suicide on a dummy variable indicating marital status of the deceased among others. In previous studies, the researchers found the similar results that married individuals have a lower risk of death than people in other marital status: this holds across a broad array of types of death.

Durkheim (1966) emphasized in his book that marriage has an important function of social integration. Through marriage, people can gain physical, psychological, social, and economic benefits, which are inversely correlated with various type of deaths. This theory is called "marriage protection." On the other hand, some scholars disagree with Durkheim. For example, some suggest that marriage has a selective mechanism, and those who cannot adapt will be eliminated. This selective mechanism could be reflected in the mortality rate. This is known as "marriage selection," and it suggests that people with certain attributes

are more likely to be considered "marriable;" some of these attributes include responsibility, stability, caring, health, and several others. Despite the difference, all of the researchers agree on one attribute: mortality is inversely correlated with marriage.

The world is developing rapidly, and major advances in technology are having a profound impact on people's lifestyles. Data used in previous studies are dated and may not reflect the situations that individuals face today. This study seeks to add to this literature by using the most recent public available mortality data. The data utilized is the United States Mortality Multiple Cause-of-Death Record of 2017 from the National Vital Statistics System of the National Center for Health Statistics (NCHS) to examine the relationship between suicide rate and divorce (2017). The data set provides detailed information about all deaths in the United States and includes individual characteristics of gender, age, education level, and race. The level of detail in this data provides an excellent opportunity to study the relationship between suicide risk and marital status from multiple perspectives. Existing studies often consider the factors of gender, age, and race, but they do not address education levels. This study adds to the literature by controlling for educational levels in addition to these other factors.

The study is organized in the following manner: Section 2 reviews existing literature, Section 3 discusses the data set used in the analysis, Section 4 summarizes the empirical methods, Section 4 details the results, and Section 5 concludes.

2. LITERATURE REVIEW

Studies on the risk of suicide by marital status have been conducted across the world. The factors determining suicide is likely sensitive to regional or cultural characteristics. In this section, these existing studies are grouped by major region.

2.1 ASIA

Kim et al. (2019) use data set by the Korean Statistical Bureau and examined 5,693,036 deaths registered from 1991 to 2013. They utilize an adjacent-categories logit model and find that the male suicide rate outweighs that of females, the likelihood of committing suicide increases with age, and that non-married people are at highest risk.

Yamauchi et al. (2012) obtain census population statistics for Japanese residents aged 15 years and older and all suicide deaths from the Japanese vital statistics for the years 1980, 1985, 1990, 1995, 2000 and 2005. They use a Poisson regression model to estimate the age-adjusted relative suicide of risk, and the results show that unemployed and divorced men were at a consistently higher risk of suicide in each year analyzed. They also find that unemployed and divorced women are at higher risk than those in other marital categories.

Akbarizadeh et.al. (2019) use logistic regression to analyze suicide data for the years 2008-2012 in the city of Bushehr, Iran. They find that the probability of death due to suicide among divorced or widowed population (not age-adjusted) was 3.5 times higher compared with the unmarried population. After adjusting for age, the fatality rate was still higher in the widowed/divorced group compared with other groups.

2.2 EUROPE

Masocco et al. (2008) use the most recent available data at the time (2000-2002) from the Italian Data Base on Mortality and estimate age-standardized mortality rates from suicide by marital status separately for men and women for three different age groups. The studies use logistic regression and they find that being married appears to be a protective factor for suicide, but the impact of being never married, divorced/separated, or widowed varies with age and gender. They have concluded that both among men and women, being unmarried, widowed or divorced/separated is associated with a higher suicide rate.

Roškar et al. (2011) study the impact of a change in marital status on suicidal behavior. In their study, they used a matching model and connected suicide victims (N=1,614) in Slovenia to their matched controls (N=4,617). The researchers compare the incidence and timing of marital status change during the last five years of individual's life. They discover that a higher percentage of suicide victims (10.7%) had a marital status change in the last five years compared with the controls (5.6%). All types of marital status changes (becoming widowed, getting divorced, getting married) were found to be risk factors for suicidal behavior. The first year after the change is critical for elevated suicidal risk, particularly for those in higher age groups.

Corcoran and Nagar (2009) analyze 1,398 suicide deaths registered in 1996-2005, Northern Ireland, using Poisson regression and the results show that males have high suicide rates compared with females. Additionally, they find that marital status has direct linkage with suicide for both male and female. Marriage, in general, is negatively associated with suicide. The relationship is substantially larger for men than women. Divorced young men, on the other hand, are found to be at high risk of suicide.

Silventoinen et al. (2013) analyze differences in marital status for both fatal and non-fatal injuries, differentiating between injuries due to accidents, violence, and suicides and assessing how these associations have changed from the 1991-1997 era to 2001-2007 era using Finnish population registers. They use Cox proportional hazards models to estimate age-adjusted incidence rates of accidents, violence, and suicides by marital status. They find that incidence rates of accidents, violence and suicides were generally lower in men and women who are married. Past or ongoing divorce is associated with increased risk of all injuries when compared with married without previous divorce. Higher incidence rates were found in men who had divorced three years ago or earlier when compared with those who had divorced later.

2.3 THE UNITED STATES

Schoenborn (2004) studies the association between marital status and health. She uses data collected from the 1999 to 2002 National Health Interview Surveys and finds that, regardless of population subgroup (age, sex, race etc.) or health indictor (fair or poor health, etc.), married adults were generally healthier than adults in other marital status categories. In a similar study, Robards et al. (2012) confirm that marital status has a significant effect on a person's health and mortality. They also discover that single and divorced people are at higher risk of negative health outcomes. Changes in marriage status in mid and later life usually leads to the decrease of life expectancy.

Smith, Mercy and Conn (1988) find that young widowed males have exceptionally high rates of suicide. They use the data collected for years 1979-1981 and find that married people have the lowest rate of suicide.

Luoma and Pearson (2002) similarly focus on widowhood and the association with mortality by examining the US national suicide mortality data set for the years 1991-1996. They break down the suicide rates by race, age group, sex, and marital status. The results indicate that as many as 1 in 400 White and African American/Black widowed men between ages of 20-35 years will die by suicide, this is comparing to 1 in 9000 married men in the general population. They also find that young widowed men are at higher risk of committing suicide than women in the same age group.

Gove (1972) investigates the psychological factors of suicidal behavior of men and women. He finds that women have been experiencing an increase in stress relative to men. It is evident that there is a greater disparity between being married and being single, widowed or divorced for men than for women by looking at the relationship between sex. marital status and suicidal behavior. This study confirms previous research with respect to sex differences in the areas of mental illness and psychological well-being.

Stack and Wasserman (1993) analyze the link between marital status and suicide with individual-level data based on a national random sample of 10,906 deaths. They use logistic regression and results indicate that low marital integration significantly increases the odds of dying from suicide.

In his related paper, Stack (1996) studies the impact of marital integration suicide, specifically looking within racial and ethnic groups. He uses logistic regression to analyze nationwide data which included information on 2,099 African American suicides and 1,729 African American natural deaths. The results indicate that being divorced or widowed significantly raises the odds of death by suicide within this racial group; being single does not. He also does a parallel analysis for Whites and concludes that marital status may be

less important for African Americans in suicide prevention. In this paper, he suggests this may be due to stronger extended family ties within the African Americans group.

Kposowa (2000) does his study to examine the effect of marital status on the risk of suicide using data from the US National Longitudinal Mortality Study, 1979–1989. He then uses the Cox proportional hazards regression model to estimate the effect of marital status, controlling for age, sex, education, family income and region of residence. The results indicate that marital status, especially divorce, has a strong impact on risk of suicide, however, only among men.

Fernquist (2009) tests the theory of status integration proposed by Gibbs and Martin (1964) using 1991-1994 United States mortality data. He compares the distribution of suicide rates to the distribution of the population in various ethnic, racial, gender, education, and age groups. The distribution of suicide rates is found to be significantly different across all demographic groups, confirming the theory proposed by Gibbs and Martin (1964).

Denney et al. (2009) use Cox proportional hazard models and individual-level, prospective data from the National Health Interview Survey Linked Mortality File (1986–2002) to examine adult suicide mortality. They find that larger family sizes and employment are associated with lower risks of suicide for both men and women. Low levels of education or being divorced or separated, widowed, or never married are associated with increased risks of suicide among men, but not among women.

Most of the empirical studies show that men have a higher risk of suicide after their marriages dissolve. Scourfield and Evans (2015) publish an article on the reasons that men might be more at risk of suicide after a relationship breakdown from a sociological point

of view. They hypothesize that men are at a higher risk of suicide due to the changing nature of intimacy, loss of honor/social networks, expecting more positive experience from marriage, actual or attempted control of partners, and the increasing importance of the care of children.

3. DATA

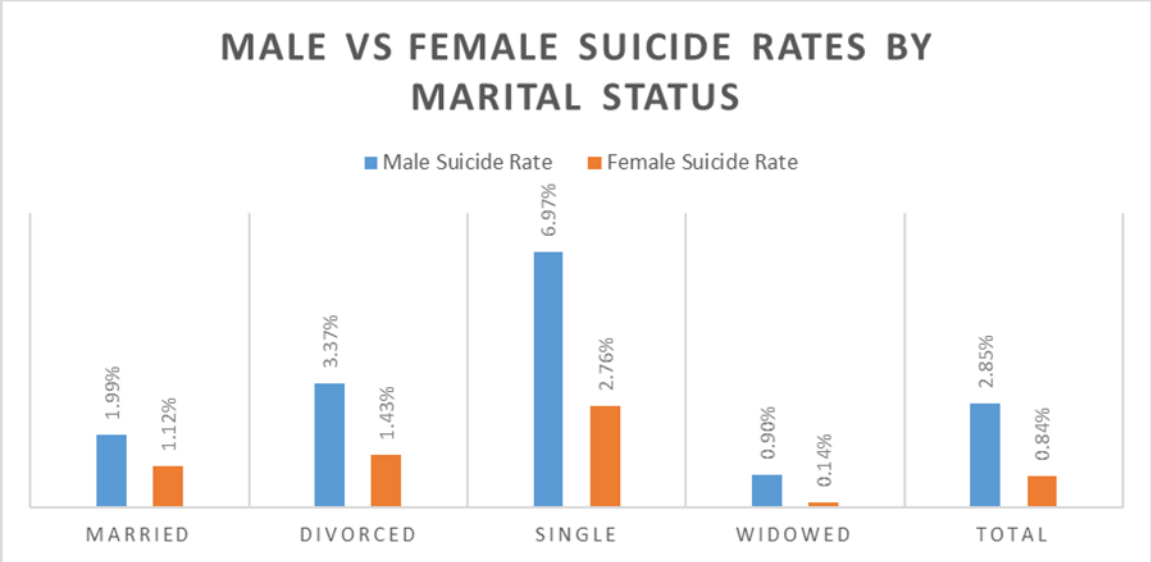
This study uses 2017 Multiple Cause-of-Death Mortality Data from the National Vital Statistics System of the National Center for Health Statistics (2017). It consists of mortality data for all deaths occurring within the United States. Each record is based on the information from death certificates filed in vital statistics offices of each state and the District of Columbia. The NCHS revised its data in 2005 to protect the identity of those in the data and excluded geographic identifiers in the publicly available datasets for the 2005 to the present. There are no specific geographic identifiers, it contains the deceased's resident status which indicates whether the person passed away in their birth location.

The data set contains a total of 2,820,034 observations. I restricted the data to only complete observations: 286,623 observations were dropped due to missing information on the underlying causes of death, 14,823 observations were dropped for missing education level, and 32,300 observations were dropped because these individuals are below marriage age (a total of about 11.8% of observations). The data set provides detailed information on each individual who died in 2017, including their resident status, age, sex, race, manner of death, education level, and marital status.

Figure 1 illustrates the fraction of each marital status-gender group that commits suicide. In general, males have a higher fraction of deaths due to suicide than females. Likewise,

those who are married tend to have a lower fraction of deaths due to suicide (for both male and female Of course, there are many colliding factors here , such as education level and race/ethnicity, which makes this analysis too simplistic.

Figure 1



Suicidality and marital status are both likely highly correlated with age. To examine this relationship, I plot the fraction of suicides in each age group by the fraction married vs unmarried (single, widowed, or divorced) in Figure 2. I use 10-year age groups ranging from age 15 to over 85, for a total of eight groups. The age groups most likely to die of suicide in this data set are those aged 45 and older.

The previous figure only looks at suicides, but to get a better look at the age distribution across all types of death, I produced a similar chart showing the fraction of total deaths by manner of death (i.e., natural, accident, suicide, homicide, etc.) across fraction in each age group in Figure 3. Most deaths are due to natural causes. Second to this include accidents, followed by suicides.

Figure 3

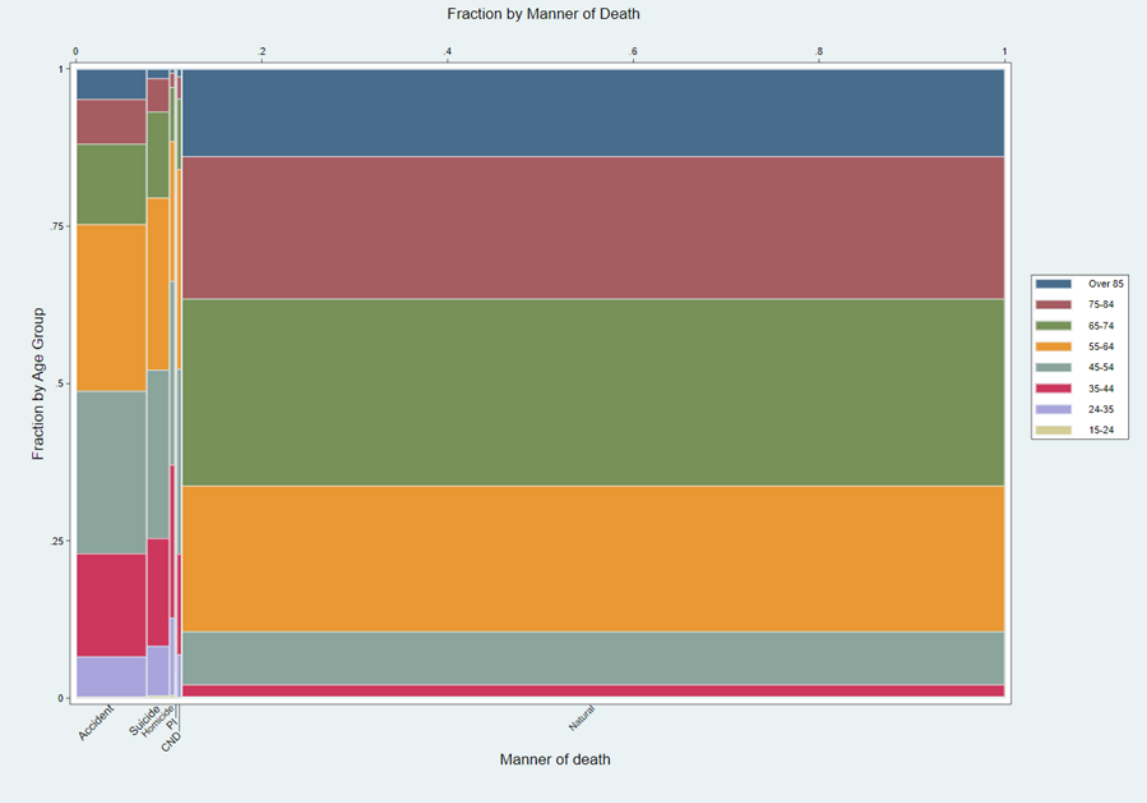
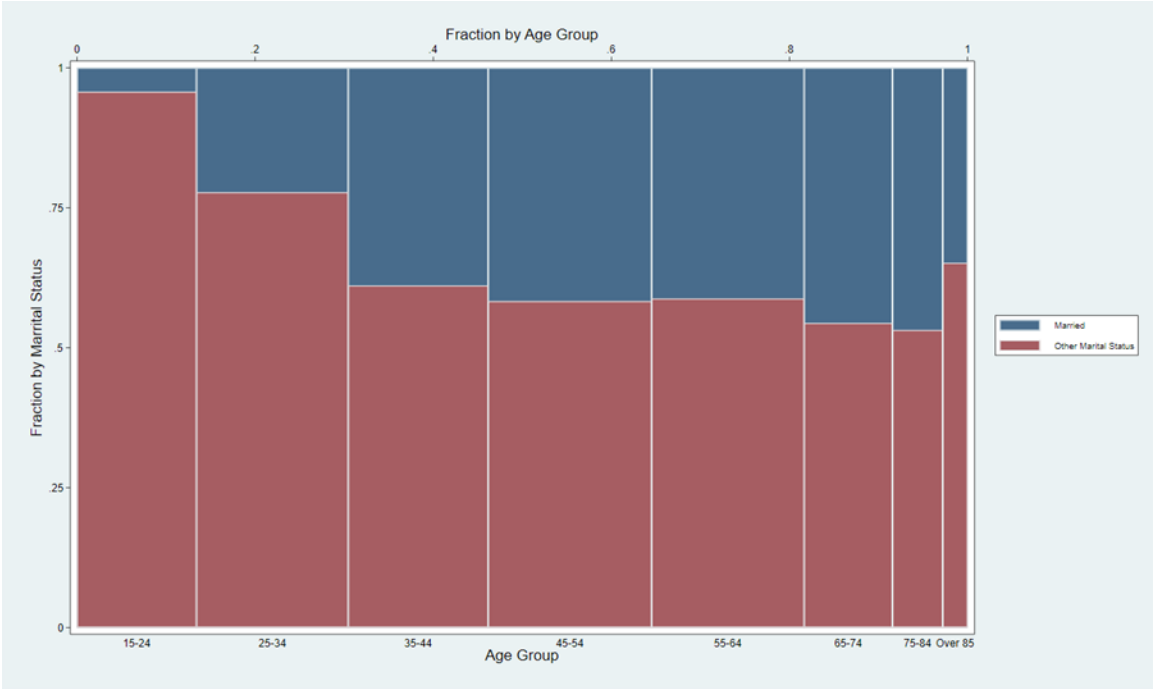
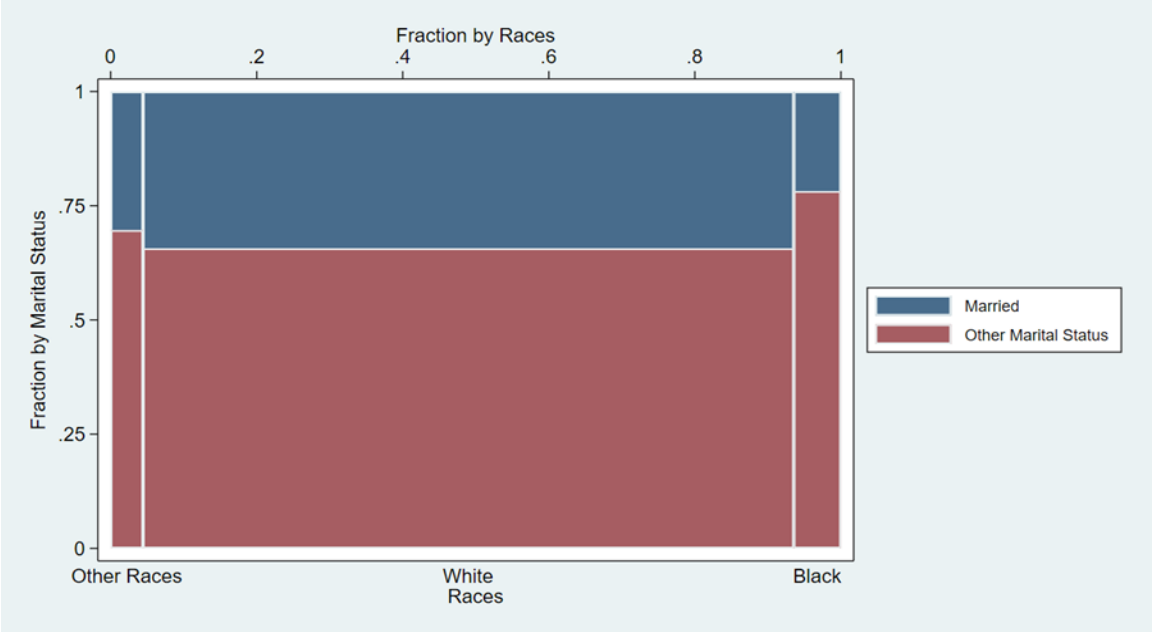


Figure 2



Race and ethnicity are also factors known to be correlated with both suicide and marital status. To examine this, Figures 4 and 5 show the fraction of suicides by simplified race variable (white, black, and other race) and Hispanic origin indicator by fraction married. I find that in 2017, 85.14% of the people committing suicide are white and 12.21% are black, and 6.00% have Hispanic origin.

Figure 4



The last factor I consider in this analysis is education level. Figure 6 shows the fraction of suicides by education level and marital status. I find that, among those who commit suicide, a high school diploma (without college) is most prevalent (43.55%). Approximately 26.30% of individuals received a bachelor's degree or higher.

Figure 5

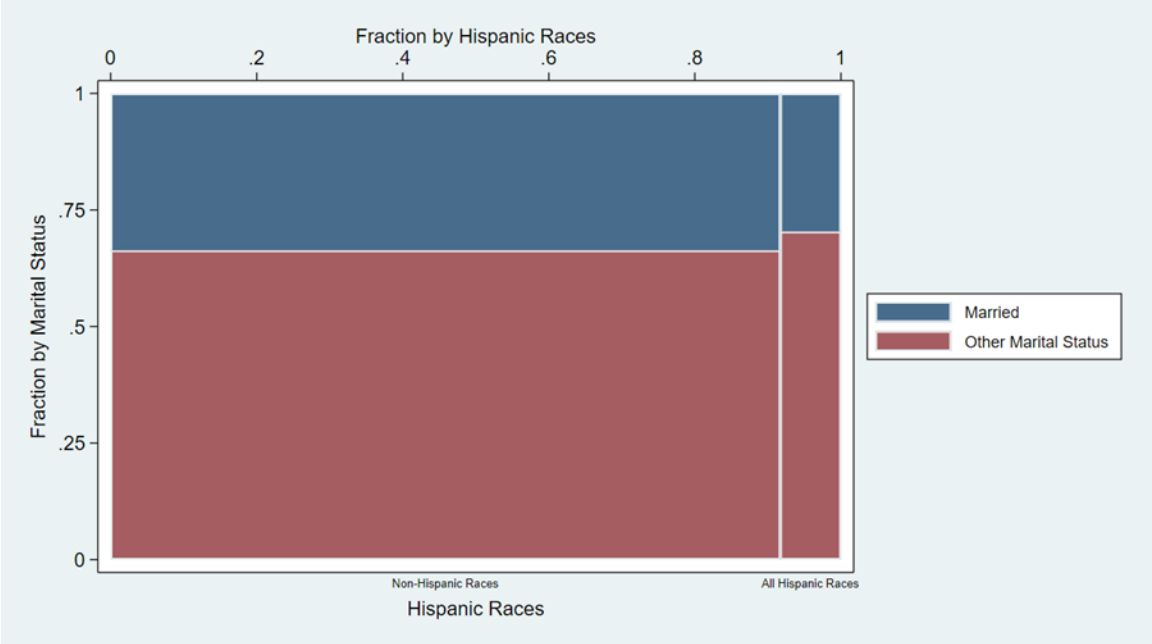
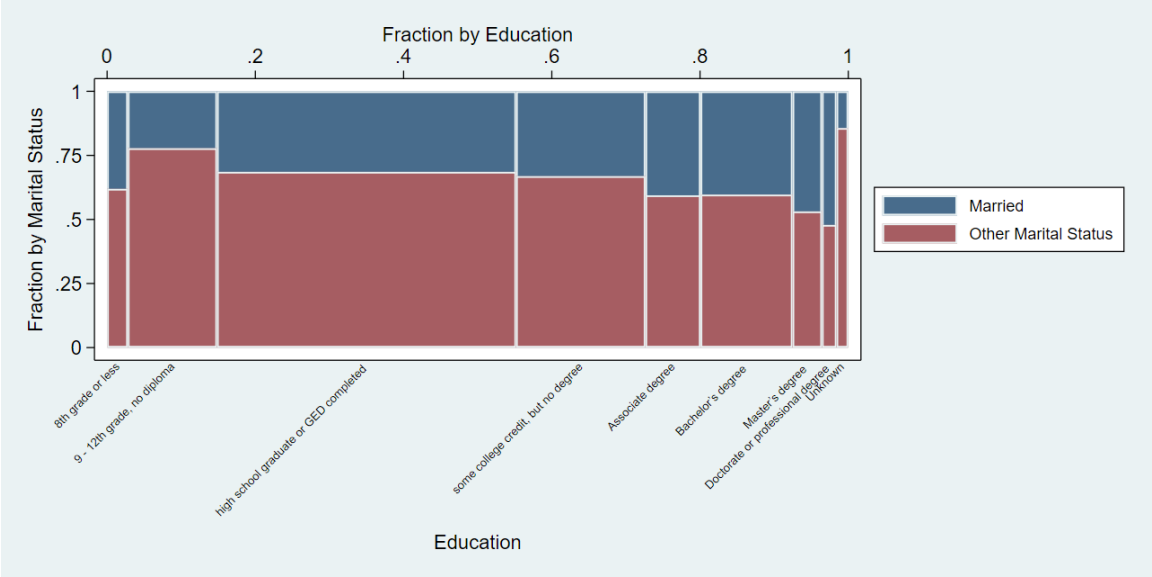


Figure 6



4. METHODOLOGY

In this analysis, I am looking to find the impact of marital status on the likelihood of committing suicide; therefore, a binary regression model is appropriate. For the simplicity of assumptions, I primarily use probit regression. The primary model used is

$$\text{Prob}(suic_i = 1|M_i) = \int_{-\infty}^{\beta \text{M}_\text{i} + \Gamma X_i + \varepsilon_\text{i}} \phi_i(t)dt = \Phi(\beta \text{M}_\text{i} + \Gamma X_i + \varepsilon_\text{i})$$

where $suic_i$ is a binary variable that takes on the value of 1 if person i committed suicide and 0 otherwise, M_i is a matrix of binary variables that indicate the marital status of person i (married, single, divorced, or widowed), X_i is a matrix of control variables for observable characteristics of person i such as education level, race, age group, and gender, and ε_i is an independent and identically distributed error term. The primary assumption of the probit model is that the probability of suicide follows a normal distribution, so ϕ is the probability density function for the normal distribution and Φ is the cumulative probability density function.

It is possible that some of the control variables are correlated with marital status. To examine how each the control variables affect the model, I also estimate the model with each factor added in separately.

5. RESULTS

The primary results for this analysis are in Table 1 below. I find that singles have a 0.251% lower probability of committing suicide, controlling for all demographics. Divorced people, on the other hand, have a 0.395% higher probability of committing suicide than those who

are married. Likewise, widows have a higher probability of 0.130%. All of the statistics are highly significant with p-values less than 0.01.

In this analysis, I control for gender, race/ethnicity, age group, and education. To control for perfect multicollinearity, the omitted category of individuals is male, married, white, ages 15-24, and have a lower education than 9^{th} grade. The coefficients of the controls should be interpreted relative to this omitted category. My study suggests that women have a lower risk of suicide than men (-1.40%). I also find decreasing probability of suicide with higher age groups. There are also significant differences between racial groups, with Whites committing suicide at significantly higher rates than Blacks. Likewise, individuals with a Hispanic origin show a lower risk of suicide. All of the coefficients are highly significant. The more surprising finding from my study is from education level. I find that those with higher education show a higher probability of committing suicide. Previous studies found the reverse of this.

I further explore the sensitivity of the model to the inclusion of various control variables. Table 2 shows the results from this analysis and Tables 3-5 break down this table for readability. With no control variables, we can see that with comparison to married people, single and divorced people have higher probability to commit suicide, and widowed people are less likely to commit suicide. However, with age-adjusted results, divorced people have just a tiny bit higher probability to commit suicide while the single and widowed group is less likely to commit suicide, but the differences are small. Controlling for gender, race/ethnicity, or education alone does not appear to change the findings from an uncontrolled model.

6. CONCLUSION

This study explores the relationship between marital status and suicide by using the probit regression model, and the results confirm the findings of previous studies. Being married for all genders, races, age groups, and education level, is a protective factor for suicidal behavior.

My study contributes to the literature in two primary ways. First, I use the most recent data available to look at the relationship between marital status and the probability of committing suicide, controlling for observable characteristics of the deceased. Secondly, I find that higher education may be correlated with higher risk of suicide, a result contrary to previous studies that found education lowers risk (Kposowa 2000; Denny et al. 2009). This potential effect of educational level on suicide is surprising and curious. Most view education as a positive force in life. Education can influence cultural development, cultural inheritance, and meet the continuation and renewal of culture. The progress of science and technology is an inevitable result of the accumulation of knowledge. Moreover, the accumulation of knowledge is the result of education. The major finding of an increased risk of suicide with education may be connected with factors such as stress, but this study is limited in scope and does not explore the reasons behind the choice of suicide. Likewise, there is a strong correlation between education and age, a factor that should be investigated in future studies.

Lastly, I find a strong correlation between age, race/ethnicity, gender, and education with marital status among suicide victims. Future analysis will explore this correlation by looking at interaction terms in the right-hand side of the model.

Table 1

	Control for all
Single	-0.00251*** (-10.08)
Widowed	0.00130*** (4.07)
Divorced	0.00395*** (17.85)
Female	-0.0140*** (-71.91)
All other race	-0.000715 (-1.54)
Black	-0.0152*** (-99.25)
Hispanic Origin	-0.00700*** (-21.69)
25 - 34	-0.0862*** (-29.26)
35 - 44	-0.132*** (-44.37)
45 - 54	-0.179*** (-60.45)
55 - 64	-0.211*** (-70.59)
65 - 74	-0.225*** (-74.78)
75- 84	-0.229*** (-76.19)
Over 85	-0.232*** (-77.01)
9 - 12th grade, no diploma	0.00272*** (7.48)
High school graduate or GED completed	0.00484*** (14.88)
Some college credit, but no degree	0.00893*** (23.61)
Associate degree	0.00900*** (20.05)
Bachelor's degree	0.0131*** (30.70)
Master's degree	0.0130*** (22.39)
Doctorate or professional degree	0.0186*** (20.78)
Unknown education level	0.00542*** (8.10)
N	2486288

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2

	No control	Control for gender	Control for age	Control for education level	Control for races	Control for Hispanic Origin	Control for gender/races/HO	Control for all
Single	0.0223***	0.0225***	-0.00453***	0.0228***	0.0245***	0.0223***	0.0245***	-0.00251***
	(101.00)	(102.10)	(-18.54)	(102.67)	(108.04)	(100.51)	(108.45)	(-10.08)
Widowed	-0.0250***	-0.0194***	-0.00442***	-0.0238***	-0.0249***	-0.0250***	-0.0194***	0.00130***
	(-79.62)	(-60.23)	(-13.94)	(-75.70)	(-79.55)	(-79.49)	(-60.37)	(4.07)
Divorced	0.00659***	0.00835***	0.00293***	0.00672***	0.00711***	0.00660***	0.00882***	0.00395***
	(28.74)	(36.09)	(13.38)	(29.23)	(31.08)	(28.82)	(38.19)	(17.85)
Female		-0.0157***					-0.0155***	-0.0140***
		(-76.23)					(-75.47)	(-71.91)
25 - 34			-0.0755***					-0.0862***
			(-26.15)					(-29.26)
35 - 44			-0.124***					-0.132***
			(-43.09)					(-44.37)
45 - 54			-0.169***					-0.179***
			(-59.26)					(-60.45)
55 - 64			-0.198***					-0.211***
			(-69.30)					(-70.59)
65 - 74			-0.211***					-0.225***
			(-73.43)					(-74.78)
75 - 84			-0.216***					-0.229***
			(-74.91)					(-76.19)
Over 85			-0.219***					-0.232***
			(-75.77)					(-77.01)
9 - 12th grade, no diploma				0.0117***				0.00272***
				(37.17)				(7.48)
High school graduate or GED completed				0.0106***				0.00484***
				(45.69)				(14.88)
Some college credit, but no degree				0.0178***				0.00893***
				(53.58)				(23.61)
Associate degree				0.0149***				0.00900***
				(36.20)				(20.05)
Bachelor's degree				0.0156***				0.0131***
				(44.65)				(30.70)
Master's degree				0.0106***				0.0130***
				(23.71)				(22.39)
Doctorate or professional degree				0.0155***				0.0186***
				(20.84)				(20.78)
Unknown education level				0.00845***				0.00542***
				(13.88)				(8.10)
All other races					0.00794***		0.00818***	-0.000715
					(12.74)		(13.05)	(-1.54)
Black					-0.0138***		-0.0135***	-0.0152***
					(-82.09)		(-79.67)	(-99.25)
Hispanic Origin						0.00237***	0.0000360	-0.00700***
						(7.41)	(0.11)	(-21.69)
N	2486288	2486288	2486288	2486288	2486288	2486288	2486288	2486288

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3

	No control	Control for education level only
Single	0.0223***	0.0228***
	(101.00)	(102.67)
Widowed	-0.0250***	-0.0238***
	(-79.62)	(-75.70)
Divorced	0.00659***	0.00672***
	(28.74)	(29.23)
9 - 12th grade, no diploma		0.0117***
		(37.17)
High school graduate or GED completed		0.0106***
		(45.69)
Some college credit, but no degree		0.0178***
		(53.58)
Associate degree		0.0149***
		(36.20)
Bachelor's degree		0.0156***
		(44.65)
Master's degree		0.0106***
		(23.71)
Doctorate or professional degree		0.0155***
		(20.84)
Unknown education level		0.00845***
		(13.88)
N	2486288	2486288

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4

	No control	Control for gender only	Control for races only	Control for Hispanic origin only	Control for gender/races/HO
Single	0.0223***	0.0225***	0.0245***	0.0223***	0.0245***
	(101.00)	(102.10)	(108.04)	(100.51)	(108.45)
Widowed	-0.0250***	-0.0194***	-0.0249***	-0.0250***	-0.0194***
	(-79.62)	(-60.23)	(-79.55)	(-79.49)	(-60.37)
Divorced	0.00659***	0.00835***	0.00711***	0.00660***	0.00882***
	(28.74)	(36.09)	(31.08)	(28.82)	(38.19)
Female		-0.0157***			-0.0155***
		(-76.23)			(-75.47)
All other races			0.00794***		0.00818***
			(12.74)		(13.05)
Black			-0.0138***		-0.0135***
			(-82.09)		(-79.67)
Hispanic Origin				0.00237***	0.0000360
				(7.41)	(0.11)
N	2486288	2486288	2486288	2486288	2486288

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5

	No control	Control for age group only
Single	0.0223***	-0.00453***
	(101.00)	(-18.54)
Widowed	-0.0250***	-0.00442***
	(-79.62)	(-13.94)
Divorced	0.00659***	0.00293***
	(28.74)	(13.38)
25 - 34		-0.0755***
		(-26.15)
35 - 44		-0.124***
		(-43.09)
45 - 54		-0.169***
		(-59.26)
55 - 64		-0.198***
		(-69.30)
65 - 74		-0.211***
		(-73.43)
75 - 84		-0.216***
		(-74.91)
Over 85		-0.219***
		(-75.77)
N	2486288	2486288

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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