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ORIGINAL RESEARCH

Diabetes Mellitus and Marital Status: Evidence from the National Longitudinal Mortality Study on the Effect of Marital Dissolution and the Death of a Spouse

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Purpose: This study evaluates the full impact of marital status on diabetes mellitus by stratifying the analysis by gender, including socioeconomic covariates and, unlike most studies, extending marital status by separating out previously conflated status categories.

Methods: Release 5 of the National Longitudinal Mortality Study (NLMS) was used for the data. Logistic regression was applied to the data from 1990 to 2011. The effective sample size consists of 1,384,507 individuals age 18 and above recruited into the study (via the Current Population Surveys), 3,955 of whom had died of diabetes mellitus by 2011.

Results: For minority men and non-Hispanic white men, divorced/separated status was significantly related to diabetes mortality, respectively (OR=1.318, CI=1.010, 1.719; and OR=1.283, CI=1.054, 1.562). For minority women and non-Hispanic white women, widowed status was related to diabetes mortality, respectively (OR=1.349, CI=1.107, 1.643; and OR=1.262, CI=1.113, 1.431).

Conclusion: Contrary to recent epidemiological studies in which divorced/separated and widowed status were combined into one covariate, this United States study finds that divorced/separated men and widowed women are at increased risk for diabetes mellitus mortality, and that among these populations at risk, minorities are at higher risk than whites. The study highlights the importance of marital status and gender differences in the risk of death from diabetes.

Keywords: diabetes, gender, divorced, widowed, socioeconomic disparities

Introduction

Diabetes Mellitus is one of the top ten causes of death in the United States. Thirty-four million people had the disease in 2017, and it is estimated that the annual cost of diabetes in the US is 327 billion dollars.[1] In addition, the risk of early death among adults with diabetes is 60% higher than those without the condition, 88 million people in the United States have prediabetes, and more than 80% of them do not know they have the disease.[1,2] Moreover, diabetes is a growing worldwide concern with the most rapid increase among low- and middle-income countries.[3] Among other factors, genetics, being overweight or obese, and stress in the form of socioeconomic disparities have been implicated as causes.[1,2] Notably in the US, while 7.5% of non-Hispanic whites have diabetes, non-Hispanic African Americans, Hispanics, and American Indians/Alaskan Natives are between 56 and

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96% more likely to be affected.[2] Less understood is the role of marital status in the disease and as a cause of death. Specifically, divorce/separated and widowed status are viewed as among the most stressful of life events but have not been fully explored with diabetes mortality.[4,5] This study evaluates the relationship between marital status and diabetes mellitus mortality by stratifying gender, and including socioeconomic covariates.

At least as far back as 1897, martial statuses different from the married have been implicated in morbidity and mortality.[6] More recent data has extended the research with the finding that social support, influence and regulation work to reduce the morbidity and mortality of those who are married.[7,8] While research on marital status and some forms of morbidity and mortality has employed the full range of marital statuses,[9,10] that generally has not been the case with diabetes research. In addition, work on marital status and diabetes has been mixed. In diabetes research in the United States, socioeconomic status has been strongly related to mortality when divorced/separated and widowed statuses were combined into one covariate.[11] Similarly, single status was related to diabetes morbidity among African American women and diabetes mortality in African American men without separating out divorced/separated from widowed status.[12]

In two recent studies based on samples from Iran, single status and a combined covariate of divorced and widowed statuses were not related to the prevalence of diabetes in a group of variables that included gender and educational attainment;[13] and in research on diabetes, hypertension, cardiovascular disease and all-cause mortality, widowed women had a lower risk of diabetes mortality.[14] Finally, in a recent study based on a population in Brazil that included race and socioeconomic factors, only a combined covariate of divorce and the widowed was significantly related to the incidence of diabetes.[15] More generally, it is common in the morbidity, mortality and obesity literature for researchers to combine divorced/separated and widowed status into one covariate.

Materials and Methods

Sample

Data were obtained from version 5 of the NLMS released in October 2015, a mortality study involving non-institutionalized persons in the United States.[16] Sponsored by the US Census Bureau and the National Center for Health Statistics, the National Longitudinal Mortality Study (NLMS) is a database established to study demographic and socioeconomic disparities among causes of mortality in the US A multistage stratified sample, it includes data from the Current Population Surveys (CPS) and the Annual Social and Economic Supplements (ASES). The data comprise almost 1.4 million records and 160,750 cases of all-cause mortality. Full information about the CPS and ASES has been previously presented.[17,18]

We use the NLMS Public Use Microdata Sample (PUMS) which is an extract of the full NLMS for purposes of analyses and ensuring the confidentiality of respondents.[16] Death certificates from April 1, 1990 to April 30, 2011 were used and link those in the CPS to mortality information available in the National Death Index (NDI) of the National Center for Health Statistics. The NDI includes deaths happening in the United States and gives researchers a way of providing mortality data in epidemiological studies. Complete information on the NDI has been previously discussed in detail.[19] Mortality was studied from 1990 to 2011, and the follow-up period included 4,018 days or 11 years, 2000–2011. Only those 18 years old and older were studied because that is the age at which all can legally marry in the US. The age restriction led to 1,384,507 individuals at the outset, 3,955 of whom died of diabetes mellitus during the follow-up time. To estimate mortality risk from diabetes, those alive after 4,018 days of follow-up, and those who died of different causes were considered right censored observations. All individuals including cases of all-cause mortality and the 3,955 who died of diabetes mellitus were included in the study. Only persons below the age 18 were excluded.

Measurements

The dependent variable was diabetes mellitus, identified by codes E08, E11, and E13 from the International Statistical Classification of Diseases, ie, death from diabetes mellitus (E11), with specified underlying conditions such as cancer and pancreatitis (E080), and other specified diabetes mellitus conditions including genetic defects (E11), obtained from the CDC standardized death certificate form.[20] Dummy variables were used. Marital status was measured by divorce/separated, single/never married, and widowed. Race/ethnicity included non-Hispanic African Americans, Non-Hispanic Asians, Non-Hispanic Native Americans, and Hispanics. For some analyses, to avoid the problem of small cell size, the race and ethnic groups were collapsed into Non-

Hispanic White Men, Minority Men, Non-Hispanic White Women and Minority Women. Place of Residence was measured by those living in cities and suburban areas within SMSAs. Housing Tenure was measured by whether the respondent owned or rented. Educational Attainment was measured by those with less than high school education, and some colleges or higher. Annual Family Income adjusted for inflation included those below $20,000, $20,000–29,999, $30,000–39,999, $50,000–59,999, and family income greater than $59,999. Age was measured by those 45–64 years, and 65 years and above. Independent variables were measured at baseline, and follow-up effects on diabetes mortality were estimated.

Statistical Analysis

Parameters were estimated with the use of logistic regression, and estimates were exponentiated to arrive at odds ratios along with 95% confidence intervals. The LOGISTIC procedure in SAS version 9.4 was utilized.[21] In the case of logistic and Cox proportional hazards regression on longitudinal data, if the variables are related to the follow-up period, results for the procedures may be different.[22,23] In these data, there were no relevant relationships between the variables and follow-up, and in the analyses reported here the logistic model was used. However, similar proportional hazards results are available upon request.

Results

As may be seen in Table 1, which is based on the descriptive statistics from the entire sample, divorce/separated and widowed status were significantly related to diabetes mortality, respectively (OR=1.147 [95%] CI=1.026, 1.282; and OR=1.262, CI=1.159, 1.374). As expected, the socioeconomic covariates, renting housing tenure, less than high school, high school educational attainment, and family income were consistent with the existing literature. Similarly, the race/ethnicity covariates of non-Hispanic African American, non-Hispanic American Indian/Alaskan Native, and Hispanic were significantly related to diabetes mortality.

Tables 2 and 3 stratify the analysis by gender and separate minority from non-Hispanic white men and women. For minority men and non-Hispanic white men (Table 2), the divorced/separated were significantly related to diabetes mortality, respectively (OR=1.318 [95%] CI =1.010, 1.19; and OR=1.283, CI=1.054, 1.562). For minority women and non-Hispanic white women (Table 3), the widowed had significant risks for mortality, respectively (OR=1.349, [95%] CI=1.107, 1.643; and OR=1.262, CI=1.113, 1.431, respectively). The socioeconomic covariates in the stratified samples (Tables 2 and 3) were comparable with those in the entire sample (Table 1) with some exceptions. Renting as opposed to owning was only significant for non-Hispanic white women; high school attainment was only significant for minority men; and minority men and women compared to white men and women in the highest family income category were not significantly less likely to die of diabetes.

Discussion

This study shows that it is important to separate out marital status into at least four categories: married, single/never married, divorced/separated and widowed, and to stratify by gender. The different marital status findings by gender in this study were unexpected and novel. It is especially important to separate out the divorce/separated from the widowed because the ages of the two statuses tend to be different. For example, in the United States, the average age for divorce is 30, while the mean age for widowhood is 59. The large sample size of the NLMS and its longitudinal nature allows for a better understanding of marital status and provides for relevant socioeconomic covariates.

The different ages for the divorced/separated compared to the widowed are likely responsible for these findings that men (both minority and non-Hispanic whites) who are divorced/separated have increased risk for diabetes, and women (minority and non-Hispanic whites), who are widowed are at increased diabetes risk. Married men may have the social support of their spouses and the social control marriage can provide with regard to eating responsibly; and without that support and control men may be at higher risk for unhealthy eating leading to obesity.[24,25] Accordingly, women may be less likely to overeat after divorce because they have been more focused on the importance of healthy eating during marriage. Widowed women have fewer partnering opportunities than the divorced/separated, and they may cope with the loss of a spouse by overeating. Compared to widowed men, women have larger friendship networks that often include social gatherings involving food at which overeating is a risk.[26,27] Some widowed men, on the contrary, are more likely to cope with the loss of a spouse by engaging

Table 1 Descriptive Statistics and the Effect of Marital Status on Diabetes Mellitus, Entire Sample, National Longitudinal Mortality Study, 1990–2011

Variable	Event	Population	β	OR	95% CI
Marital Status					
Married	2198	861,220	Reference	1.000	
Divorce/separated	418	138,473	0.137**	1.147	1.026,1.282
Single/never married	285	282,417	−0.0705	0.932	0.817,1.063
Widowed	1054	102,397	0.232***	1.262	1.159,1.374
Sex					
Female	2120	733,740	Reference	1.000	
Male	1835	650,767	0.205***	1.228	1.148,1.313
Race/Ethnicity					
Non-Hispanic White	2813	1,059,208	Reference	1.000	
Non-Hispanic African American	565	119,249	0.519***	1.680	1.525,1.850
Non-Hispanic American Indian	54	11,170	0.827***	2.286	1.740,3.005
Non-Hispanic Asian	45	30,533	−0.225	0.799	0.594,1.074
Hispanic	461	157,877	0.267***	1.306	1.179,1.446
Non-Hispanic Other	17	6470	0.456	1.578	0.976,2.551
Place of Residence					
Rural Area	1410	552,109	Reference	1.000	
Central City of SMSA	1225	385,787	−0.005	0.995	0.918,1.078
Outside Central City in SMSA	1320	446,611	−0.103**	0.902	0.835,0.974
Housing Tenure					
Own Home	2820	964,143	Reference	1.000	
Rents	1135	420,364	0.095**	1.100	1.020,1.187
Educational Attainment					
Some College	760	527,962	Reference	1.000	
Less High School	2075	340,419	0.475***	1.609	1.468, 1.763
High School Graduate	1120	516,126	0.149***	1.161	1.057, 1.276
Family Income					
$40,000–49,999	188	113,704	Reference	1.000	
< $20,000	2209	432,607	0.367***	1.443	1.236,1.686
$20,000–29,999	675	255,242	0.198**	1.219	1.036,1.435
$30,000–39,999	381	194,937	0.091	1.096	0.920,1.306
$50,000–59,999	199	159,893	−0.181	0.834	0.683,1.019
$60,000+	239	200,419	−0.297**	0.743	0.613,0.901
Income missing	64	27,705	−0.138	0.871	0.654,1.159
Age					
18–44	331	787,597	Reference	1.000	
45–64	1310	377,406	2.091***	8.095	7.131,9.189
65+	2314	219,504	2.952***	19.136	16.829,21.759
Intercept		−8.2840			
−2LogL		48,130.87			
LRS		6105.53***			
Df		22			
Events/Population	3955	1,384,507			

Notes: **p < 0.01; ***p< 0.001.

Table 2 Minority Men and Non-Hispanic White Men: Effect of Marital Status on Diabetes

Variable	Minority Men			Non-Hispanic White Men		
	β	OR	95% CI	β	OR	95% CI
Marital Status						
Married	Ref	1.000		Ref	1.000	Ref
Divorce/separated	0.276*	1.318	1.010, 1.719	0.250**	1.283	1.054, 1.562
Single/never married	−0.120	0.887	0.642, 1.226	−0.081	0.922	0.738, 1.153
Widowed	0.044	1.045	0.759, 1.438	0.177	1.194	0.989, 1.442
Place of Residence						
Rural Area	Ref	1.000		Ref	1.000	
Central City of SMSA	0.119	1.127	0.905, 1.402	−0.017	0.983	0.854, 1.131
Outside Central City in SMSA	0.022	1.022	0.796, 1.313	−0.234***	0.791	0.698, 0.898
Housing Tenure						
Own Home	Ref	1.000		Ref	1.000	
Rents	−0.172	0.842	0.686, 1.033	0.105	1.111	0.964, 1.281
Educational Attainment						
Some College	Ref	1.000		Ref	1.000	
Less High School	0.604***	1.829	1.360, 2.458	0.285***	1.329	1.148,1.539
High School Graduate	0.583***	1.791	1.312, 2.444	0.131	1.140	0.986, 1.318
Family Income						
$40,000–49,999	Ref	1.000		Ref	1.000	
< $20,000	0.413*	1.511	0.988, 2.311	0.385**	1.470	1.152, 1.875
$20,000–29,999	0.075	1.078	0.683, 1.701	0.262*	1.299	1.011, 1.669
$30,000–39,999	0.196	1.217	0.756, 1.959	0.122	1.129	0.865, 1.475
$50,000–59,999	−0.398	0.672	0.362, 1.246	−0.185	0.831	0.617, 1.120
$60,000+	−0.195	0.823	0.477, 1.419	−0.31*	0.734	0.551, 0.977
Income missing	−0.105	0.900	0.384, 2.110	−0.272	0.762	0.466, 1.246
Age						
18–44	Ref	1.000		Ref	1.000	
45–64	1.967***	7.150	5.309, 9.629	1.992***	7.328	5.933, 9.049
65+	2.799***	16.427	12.034, 22.425	2.924***	18.623	15.063, 23.023
Intercept	−7.8284			−7.8900***		
−2LogL	5843.501			16,711.39		
LRS	749.85***			1877.82***		
Df	16			16		
Events	491			1343		
Population	149,090			501,210		

Notes: *p <0.05; **p < 0.01; ***p< 0.001.

in more dangerous activity leading to early morbidity and mortality related to alcohol and drug use, accidents, homicide and suicide.[28,29]

Our findings should be viewed in the context of some potential limitations. First, research has generally indicated that diabetes is underreported as a cause of death. Death certificates may not include diabetes as a cause of death because certifying physicians did not know or believe it was a cause, the decedent had other diseases thought to be more causally important, and death certificates have limited space for recording death.[30] As with some other causes of death, this evidence suggests that reported diabetes deaths, if not a measure of all diabetes mortality, are nevertheless a good measure of death from the most serious diabetes, and diabetes morbidity that is less complicated by different causal understanding of atherosclerotic and hypertensive cardiovascular disease. More research is needed on the chain of causality in diabetes morbidity.

Table 3 Minority Women and Non-Hispanic White Women: Effect of Marital Status on Diabetes

Variable	Minority Women			Non-Hispanic White Women		
	β	OR	95% CI	β	OR	95% CI
Marital Status						
Married	Ref.	1.000		Ref.	1.000	Ref.
Divorce/separated	0.018	1.018	0.79, 1.30	0.120	1.128	0.923, 1.38
Single/never married	−0.035	0.966	0.708,1.316	−0.032	0.969	0.760, 1.234
Widowed	0.299**	1.349	1.107,1.643	0.233***	1.262	1.113, 1.431
Place of Residence						
Rural Area	Ref.	1.000		Ref	1.000	
Central City of SMSA	0.085	1.089	0.895,1.326	−0.017	0.983	0.859,1.125
Outside Central City in SMSA	0.118	1.126	0.901,1.406	−0.032	0.969	0.859,1.092
Housing Tenure						
Own Home	Ref.	1.000		Ref	1.000	
Rents	0.117	1.124	0.947,1.334	0.135*	1.145	1.013, 1.295
Educational Attainment						
Some College	Ref.	1.000		Ref	1.000	
Less High School	0.603***	1.828	1.401,2.387	0.622***	1.864	1.604, 2.165
High School Graduate	0.164	1.178	0.877,1.583	0.117	1.124	0.964,1.311
Family Income						
$40,000–49,999	Ref.	1.000		Ref	1.000	
< $20,000	0.684**	1.982	1.208, 3.252	0.281*	1.324	1.019,1.722
$20,000–29,999	0.378	1.460	0.862, 2.472	0.143	1.153	0.875,1.520
$30,000–39,999	0.206	1.229	0.694, 2.177	−0.003	0.997	0.738,1.347
$50,000–59,999	0.482	1.620	0.881, 2.978	−0.338*	0.713	0.503,1.013
$60,000+	0.069	1.072	0.577, 1.991	−0.465**	0.628	0.447,0.882
Income missing	0.603	1.828	0.848, 3.942	−0.256	0.774	0.490,1.224
Age						
18–44	Ref	1.000		Ref	1.000	
45–64	2.451***	11.595	8.483,15.848	2.07***	7.927	6.254,10.048
65+	3.082***	21.810	15.73, 0.241	2.968***	19.454	15.364, 24.633
Intercept	−8.5607***			−8.321***		
−2LogL	7412.991			18,070.69		
LRS	1127.3***			2326.4***		
Df	16			16		
Events	647			1470		
Population	175,273			557,998		

Notes: *p <0.05; **p < 0.01; ***p< 0.001.

However, it is important to understand that we must not minimize the fact that many people with diabetes die of other causes, especially cardiovascular disease and cancer.

Second, because of limitations of the NLMS data, the effects of genetics and health variables could not be estimated in this research. This study, based on the largest US sample, focused on the importance of marital statuses–and the full spectrum of marital statuses–in diabetes mellitus and found high mortality risk for large populations of people: divorced/separated minority and white men, and widowed minority and white women. Going forward, additional work on marital status and diabetes is indicated.

Finally, while we were able to separate out divorced/separated status from the widowed, the data do not allow us to separate the divorced from those who are separated. Divorce is quite distinct from separation. Separation can be of an extended amount of time and be a source of considerable stress. Researchers can also conflate

separated and single status when it comes to identifying different marital statuses. As noted, in this study, divorced/separated and single/never married were different covariates.

Conclusion

This study examined diabetes mortality with the findings that the marital statuses of divorce/separated and widowed were differentially related when gender was stratified. Unlike most recent studies in which divorced/separated and widowed status were combined into one covariate, this research on the most recent version of the NLMS covering nearly 1.4 million deaths finds that divorced/separated men and widowed women are at increased risk for diabetes mortality. Specifically, minority men and non-Hispanic white men who were divorced/separated had significantly higher risk for death from diabetes mellitus, a 43 and 28% increase, respectively; and minority women and non-Hispanic white women who were widowed had a similarly high risk for diabetes mortality, a 35 and 26% corresponding increase, respectively. In addition to previous work on socioeconomic disparities, this study highlights the importance of marital status and gender differences in the risk of death from diabetes.

Ethical Approval and Informed Consent

Research for this study did not require an institutional review board or ethics committee. NLMS data are publicly available to researchers on the World Wide Web and all the data are anonymized prior to release. Without identifying information consent was not needed.

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Disclosure

The authors report no conflicts of interest in this study.

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