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Major Physical Health Conditions and Risk of Suicide

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Abstract

Introduction—Most individuals make healthcare visits before suicide, but many do not have a diagnosed mental health condition. This study seeks to investigate suicide risk among patients with a range of physical health conditions in a U.S. general population sample and whether risk persists after adjustment for mental health and substance use diagnoses.

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Methods—This study included 2,674 individuals who died by suicide between 2000 and 2013 along with 267,400 controls matched on year and location in a case-control study conducted in 2016 across eight Mental Health Research Network healthcare systems. A total of 19 physical health conditions were identified using diagnostic codes within the healthcare systems' Virtual Data Warehouse, including electronic health record and insurance claims data, during the year before index date.

Results—Seventeen physical health conditions were associated with increased suicide risk after adjustment for age and sex ($p<0.001$); nine associations persisted after additional adjustment for mental health and substance use diagnoses. Three conditions had a >twofold increased suicide risk, including traumatic brain injury (AOR=8.80, $p<0.001$), sleep disorders, and HIV/AIDS. Multimorbidity was present in 38% of cases versus 15.5% of controls, and represented nearly a twofold increased risk for suicide.

Conclusions—Although several individual conditions, such as traumatic brain injury, were associated with high risk of suicide, nearly all physical health conditions increased suicide risk, even after adjustment for potential confounders. In addition, having multiple physical health conditions increased suicide risk substantially. These data support suicide prevention based on the overall burden of physical health.

Introduction

In April 2016, the Centers for Disease Control and Prevention released a report documenting a 24% rise in the U.S. national suicide rate between 1999 and 2014.¹ The U.S. suicide rate, now reaching 13 per 100,000, is at its highest mark in 30 years. Importantly, suicide rates increased for both male and female individuals as well as across all age groups from 10 to 74 years.¹ National data indicate that from 2005 to 2012 the age-adjusted mortality rates declined for each of the top ten causes of death in the U.S., except for suicide.^{2,3} Taken together, these findings place a national spotlight on the urgent need to develop, disseminate, and implement more-effective suicide prevention practices.³

The 2012 National Strategy for Suicide Prevention has provided an evidence-informed roadmap, including a series of aspirational goals and objectives, to reduce suicide in the U.S.⁴ Specifically, Aspirational Goals 8 and 9 promote all healthcare settings as one of the most promising and critical environments to implement suicide prevention practices.⁵ This is consistent with data showing that more than 80% of individuals make a healthcare visit in the year before suicide, and nearly 50% have a visit within 4 weeks of their death.⁶

In healthcare settings, patients receive services delivered by clinical providers, who have the opportunity to detect suicide risk and intervene. To date, health systems have generally targeted suicide prevention and intervention for patients with known risk focusing primarily on individuals with mental health and substance use conditions or those with expressed suicidal ideation.^{7,8} Supporting this approach are studies based on psychological autopsy reports indicating that 90% of individuals who die by suicide may meet criteria for a psychiatric condition.⁹ Although several interventions have reduced suicide rates in these targeted behavioral health patient populations,^{10–13} these efforts have not made a measureable difference in reducing the overall population suicide rate.

A major reason for the limited impact of these targeted interventions is that most individuals do not have a diagnosed mental health condition, nor do they receive behavioral health specialty care. National findings estimate that, among people who die by suicide, only 45% have a mental health or substance use diagnosis in the prior year; furthermore, only 14% have a mental health– related inpatient hospital stay and 29% receive specialty behavioral health outpatient treatment.⁶ These data suggest that either: (1) mental health conditions are largely unidentified in medical settings; (2) mental health symptoms often do not present until very near the time of suicide; or (3) many patients do not actually have a mental health condition before suicide. More importantly, these data argue that suicide prevention targeted only to patients in behavioral health settings will necessarily miss the majority of individuals at risk for suicide, which is why identification in general medical settings is so vital. Nonetheless, the U.S. Preventive Services Task Force recently determined that evidence was insufficient to inform recommendations on suicide screening and prevention in primary care settings.¹⁴

Research from several countries outside the U.S. as well as from the U.S. military and veteran populations suggests that many physical health conditions may increase suicide risk. These studies show that chronic pain, heart disease, chronic obstructive pulmonary disease, stroke, cancer, congestive heart failure, and asthma have all been associated with increased risk for suicide.^{15–19} Research also suggests that having multiple physical health conditions may be linked with even greater risk for suicide.¹⁶ It is unclear whether the association between physical health conditions and suicide is restricted to only a small set of specific conditions or whether most conditions increase risk. Risk data could be used to identify individuals for targeted prevention in general medical settings. However, similar analyses have not been available for the U.S. general population, which has a vastly different healthcare system and culture than other countries or the military. The current study seeks to examine major physical health conditions as risk factors for suicide, while also adjusting for mental health or substance use diagnoses, in a large case-control study within eight U.S. healthcare systems. The investigation includes a series of both common and rare diagnoses that may be associated with suicide risk, and have been investigated in these other populations.

Methods

Study Sample

This case-control study was conducted within the Mental Health Research Network, a consortium of 13 learning healthcare systems, which annually serve >12.5 million individuals across 15 states.^{20,21} These systems all provide a comprehensive array of primary and specialty care, and have affiliated research centers and health insurance plans. The combination of health system and health plan membership allows the capture of data on nearly all healthcare utilization both within and outside of the health system via electronic health records and insurance claims records. The current study involved eight Mental Health Research Network health systems, including: Group Health Cooperative (Washington), HealthPartners (Minnesota), Harvard Pilgrim Healthcare (Massachusetts), Henry Ford

Health System (Michigan), and Kaiser Permanente health systems in Colorado, Georgia, Hawaii, and Oregon. IRBs at each site approved data use for this project.

A total of 2,674 individuals who died by suicide (cases) from 2000 to 2013, were members of the participating health systems, and were continuously enrolled in the health plan for 10 months during the year before their death were included in this study. The 10-month enrollment criterion was used to capture all healthcare utilization occurring before suicide, but allow for a short gap given that individuals are often disenrolled from health plans for the month of their death. A randomly selected sample of 100 members, enrolled during the same time period at the system, were matched to each case for a total of 267,400 general population control individuals. The date of suicide for cases was considered the index date and all matched controls were assigned the same corresponding index date. Thus, all cases and controls were effectively matched by time period and site.

Measures

All Mental Health Research Network–affiliated health systems maintain a Virtual Data Warehouse (VDW) consisting of electronic health record and insurance claims data for their enrolled health plan members.^{6,22–24} Data were available for healthcare encounters, diagnoses, and demographics. All VDW data were organized using the same variables and data definitions across sites and are subject to regular quality verification. These data were also matched to official mortality records using Social Security numbers or a combination of patient names, birthdates, and demographic profiles.

For the current study, individuals who died by suicide were identified from VDW using ICD-10 codes ranging from X60 to X84 and Y87.0.²⁵ In addition, ICD-9 codes were captured from health system encounters, permitting the identification of diagnoses within the year prior to the index date for all individuals.²⁶ Diagnoses were extracted for defined mental health and substance use conditions (ICD-9 codes 290–319) and 19 physical health conditions, including asthma (493), back pain (720.0–724.9), cancer (140–209), congestive heart failure (402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 428), chronic obstructive pulmonary disease (490–492, 494, 496), diabetes mellitus (250), epilepsy (345), fibromyalgia (729.1), heart disease (410–414), HIV/AIDS (042, 043, 044, V08), hypertension (401), migraine (346), multiple sclerosis (340), osteoporosis (733.0–733.09), Parkinson's disease (332), psychogenic pain (307.8, 307.89), renal disease (403, 582, 583, 585, 586, 588, 404.02, 404.12, 404.92, 593.9), sleep disorder (291.82, 307.4, 327, 780.5), and traumatic brain injury (800, 801, 803, 804, 850–854). These conditions were chosen because they are defined conditions that have been studied in relation to suicide risk in other populations. Multimorbidity was defined as having more than one of these conditions.

Demographic information on age and sex were available from VDW. For each person, estimated neighborhood income and education were calculated using geocoded addresses and Census block data. Race and ethnicity data were not available for several sites prior to 2008, thus these variables were not included in the study.

Statistical Analysis

Descriptive statistics were used to characterize the sample by study group. Demographic characteristics included age in years, sex (male/female), education (proportion of individuals living in Census blocks where 25% are college graduates), and income (proportion of individuals living in Census blocks where >20% have incomes below the U.S. poverty level). Then, the rate of each physical health diagnosis was calculated for each study group. Conditional logistic regression models were used to calculate the unadjusted and adjusted odds of suicide associated with each diagnosis. All models were conditional on site, and adjusted models initially controlled for age and sex and then also for mental health and substance use diagnoses. Finally, unadjusted and adjusted logistic regression models were used to estimate the odds of suicide for individuals with zero, one, or two or more of the 19 physical health conditions. All analyses were conducted using SAS Statistical Software, version 9.4. Statistical significance was assessed with a threshold of $p=0.05$.

Results

Table 1 presents the demographic characteristics of the sample, stratified by study group (cases and controls). Overall, individuals who died by suicide were much more likely to be male as compared with individuals in the control group (77.5% vs 47.5%, $p<0.001$). In addition, the average age for the cases was >10 years older than for the control group (49.9 vs 39.4 years, $p<0.001$). However, there were no differences in income and education level between groups.

Sixteen physical health conditions were individually associated with suicide in unadjusted models ($p<0.001$ for each) (Table 2). Hypertension and back pain were the most common conditions for both those who died by suicide (27.8% and 22.6%, respectively) and the control group (15.4% and 11.5%, respectively). Multiple sclerosis was the least common condition among the case group (0.4%) as compared with HIV/AIDS for the control group (0.1%). In models adjusted for age and sex, 17 conditions were associated with suicide, including the same 16 conditions as well as asthma (Table 3). In the final adjusted models, which included additional adjustment for mental health and substance use diagnoses, nine physical health conditions were associated with suicide.

Though the two most common conditions were both moderately associated with suicide (hypertension, OR=2.12, $p<0.001$; back pain, OR=2.25, $p<0.001$), the largest increased odds were observed for traumatic brain injury (OR=14.96, $p<0.001$), which remained the greatest-magnitude risk factor after adjustment for age, sex, and any psychiatric condition (AOR=8.80, $p<0.001$). HIV/AIDS (AOR=2.14, $p<0.001$) was strongly associated with suicide, but was uncommon in both the case and control groups (<1% in each group). By contrast, nearly 19% of those who died by suicide had a diagnosed sleep disorder as compared with <5% of controls, and this condition was also strongly associated with suicide (AOR=2.08, $p<0.001$).

Physical health multimorbidity was much less common in the control group than the case group, as 64% ($n=171,044$) did not have any of the 19 conditions under study and only 15.5% ($n=41,544$) had two or more conditions (Table 4). By contrast, 38.2% ($n=1,020$) of

those who died by suicide had multiple physical health conditions versus 38.3% ($n=420$) without any of these diagnosed conditions. Having two or more diagnosed physical conditions was associated with an increased risk for suicide (OR=4.12, $p<0.001$), even after statistical adjustment for age, sex, and any psychiatric condition (AOR=1.70, $p<0.001$).

Discussion

After completing a comprehensive systematic review in 2013, the U.S. Preventive Services Task Force concluded that there was insufficient evidence to recommend screening or treatment for suicide risk in primary care settings.¹⁴ Although research has indicated that the majority of individuals receive health services in primary care or general medical specialty settings—and much less often in specialty behavioral health settings—in the weeks and months before suicide,⁶ there have been limited data available to determine how to target suicide prevention within these settings. This knowledge could be useful because the base rate of suicide among patients seen in these settings is low, which has engendered concerns that widespread suicide prevention for all patients would be burdensome, costly, and ineffective.²⁷ The present study provides evidence on defined physical health conditions. It is part of a larger project that seeks to identify clinical risk factors for suicide using healthcare data that can be combined to develop an algorithm to better detect suicide risk in clinical settings. This effort has particular clinical relevance, given that some research suggests these algorithms embedded within electronic health records systems may better predict suicide risk than clinical assessments alone.²⁸ The Veterans Health Administration has recently launched a clinical initiative based on their algorithm.²⁹ Overall, use of healthcare data to better predict suicide risk among patients has been established as a major short-term research priority in the U.S.³⁰

In this study, there was a robust association between 17 physical health conditions and suicide. Though the co-occurrence of mental health and substance use diagnoses attenuated all associations, nine relationships persisted after adjustment. Furthermore, nearly 62% of individuals who died by suicide had a diagnosis of at least one of these conditions in the year before their death. This is compared with the control group, among whom 64% of the sample did not have any of these conditions. Considering these conditions are among the most common reasons for physician visits in the U.S.,³¹ widespread suicide prevention efforts in all healthcare settings seem warranted. Consistent with these findings, the Joint Commission—the major hospital accrediting body in the U.S.—released Sentinel Event Alert #56 in February 2016, which urged U.S. hospitals and health systems to screen for and treat suicide in all settings (i.e., outpatient, inpatient, and emergency).³² The Sentinel Event Alert recommends the Zero Suicide Model, a healthcare system suicide prevention approach with evidence-based screening, care management, and treatment interventions, including lower-intensity interventions such as safety planning and caring contacts as well as higher-intensity interventions like dialectical behavior therapy or cognitive behavioral therapy to prevent suicide.³³

Although suicide risk appears to be pervasive across most physical health conditions, prevention efforts appear to be particularly important for patients with a traumatic brain injury, whose odds of suicide are increased nearly ninefold, even after adjusting for potential

confounders. Traumatic brain injury has received considerable attention recently for its possible link to suicide, particularly among individuals in the military and those who participate in high-impact sports.^{34,35} This finding suggests that there may be a specific relationship between diseases of the brain and risk of suicide, especially given the findings for migraine headache and stroke. This is the first large, multisite study conducted within the general U.S. population demonstrating a significant, large-magnitude relationship between brain injury and suicide.

In addition, it may be especially important to assess suicide risk among patients with sleep disorders and HIV/AIDS. These conditions had more than a twofold increased risk for suicide, even after adjustment for mental health and substance use diagnoses. In combination with this U.S.-based study, there are now emerging data from studies across the world demonstrating a link between sleep disturbance and suicide.³⁶ Furthermore, though there was a moderate association between back pain and suicide risk, this condition is also important given that it was highly prevalent among those who died by suicide. Previous research in the U.S. veteran population has implicated chronic back pain as a strong risk factor for suicide.¹⁹ Research is needed to determine whether opioid use for pain management contributes to this risk.³⁷ Future research may also investigate whether other underlying conditions may play a role in each of these associations and risk for suicide.

Interestingly, this study did not find a relationship between psychogenic pain and suicide after adjusting for mental health and substance use diagnoses. This is in contrast to a study in the U.S. veteran population.¹⁹ Given that patients with psychogenic conditions are often treated, at least partially, in behavioral health,³⁸ they may be more likely to have a mental health diagnosis. This diagnosis may mediate the relationship between psychogenic pain and suicide.

Having multiple physical health conditions may be one of the most important factors to consider with respect to suicide risk. In this study, more than 38% of individuals who died by suicide had more than one of the 19 physical health conditions investigated with less than 16% of the control group. Although the authors do not have data on severity of illness, these findings point to an effect of the overall burden of illness on suicide risk, which is consistent with findings from a study in Canada.¹⁶ Given that individuals with multiple conditions are often seen by providers in various general and specialty settings,³⁹ there should be numerous opportunities to integrate suicide prevention into their care.

Limitations

This study should be considered in the context of limitations. First, all individuals had health insurance, including commercial insurance, Medicaid, and Medicare, and were members of well-resourced health systems. Therefore, the association between physical health conditions and suicide may differ for those without insurance. Second, though the individuals studied here were from multiple states, not all U.S. states or healthcare settings were represented. Third, many case-control studies on suicide are age and sex matched. The authors limited matching to location and year, so that future analyses in this line of research could investigate variation in subgroups through analyses using interaction, stratification, and adjustment. In lieu of matching, this study adjusted the analyses for both age and sex.

Fourth, race/ethnicity data were not available for these analyses, as they were not captured routinely by many health systems until 2009. Finally, the study was limited to diagnoses coded by providers, which may be inaccurate estimates of each condition.

Conclusions

This study provides the first available evidence of the risk of suicide among individuals with major physical health conditions in the U.S. general population. Several conditions, such as back pain, sleep disorders, and traumatic brain injury were all associated with suicide risk and are commonly diagnosed, making patients with these conditions primary targets for suicide prevention. Patients with multiple chronic conditions were also at significantly increased risk for suicide. Nonetheless, given that nearly every physical health condition was associated with suicide, widespread suicide prevention efforts in all healthcare settings seems warranted.

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Table 1
Demographic Characteristics of the Sample

Demographic category	Randomly-selected matched controls (n=267,400)	Individuals who died by suicide/cases (n=2,674)	Statistical significance
	%	%	<i>p</i> -value
Male (ref. Female)	47.5	77.5	<0.001
Low income ^a	9.8	10.2	0.504
Education ^b	36.8	38.3	0.113
Age, m (SD)	39.4 (21.9)	49.9 (19.0)	<0.001

Note: Boldface indicates statistical significance ($p < 0.05$).

^aLow income is defined as the proportion of individuals living in Census blocks where >20% of residents have incomes below the U.S. poverty level.

^bEducation is defined as the proportion of individuals living in Census blocks where 25% are college graduates.

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Table 2
Risk of Suicide Among Individuals With Physical Health Conditions

Condition	Control (n=267,400)		Case (n=2,674)		OR	95% CI	p-value
	% (n)	% (n)	% (n)	% (n)			
Asthma	5.6 (15,021)	6.2 (166)	1.11	0.95, 1.30	0.187		
Back pain	11.5 (30,669)	22.6 (603)	2.25	2.06, 2.47	<0.001		
Brain injury ^a	0.5 (1,210)	6.4 (120)	14.96	12.68, 17.65	<0.001		
Cancer	3.3 (8,883)	8.7 (232)	2.77	2.42, 3.17	<0.001		
CHF	1.3 (3,463)	4.4 (118)	3.53	2.92, 4.25	<0.001		
COPD	4.0 (10,657)	10.1 (269)	2.7	2.38, 3.07	<0.001		
Diabetes	6.1 (16,380)	11.6 (311)	2.02	1.79, 2.24	<0.001		
Epilepsy	0.4 (1,111)	1.4 (38)	3.46	2.50, 4.79	<0.001		
HIV/AIDS	0.1 (380)	0.8 (21)	5.58	3.59, 8.67	<0.001		
Heart disease	3.2 (8,643)	8.3 (221)	2.7	2.35, 3.11	<0.001		
Hypertension	15.4 (41,162)	27.8 (742)	2.12	1.95, 2.31	<0.001		
Migraine	1.9 (5,174)	3.5 (94)	1.85	1.50, 2.28	<0.001		
Multiple sclerosis	0.2 (611)	0.4 (10)	1.64	0.88, 3.07	0.122		
Osteoporosis	1.5 (3,941)	1.8 (48)	1.22	0.92, 1.63	0.171		
Parkinson's	0.2 (507)	0.8 (21)	4.17	2.69, 6.46	<0.001		
Psychogenic pain	0.5 (1,288)	1.1 (30)	2.35	1.63, 3.38	<0.001		
Renal disorder	2.3 (6,255)	6.4 (172)	2.88	2.46, 3.37	<0.001		
Sleep disorders	4.6 (12,334)	18.5 (495)	4.74	4.29, 5.23	<0.001		
Stroke	0.9 (2,372)	3.3 (88)	3.81	3.07, 4.73	<0.001		

Note: Boldface indicates statistical significance ($p < 0.05$). Logistic regression models are conditional on site.

^a Conditions: Brain injury denotes traumatic brain injury.

CHF, congestive heart failure; COPD, chronic obstructive pulmonary disorder; Diabetes, diabetes mellitus; Parkinson's, Parkinson's disease

Table 3
Adjusted Odds of Suicide Among Individuals With Physical Health Conditions

Condition	OR (Adjusted for sex and age)			OR (Adjusted for sex, age, mental health and substance use diagnoses)		
	AOR	95% CI	p-value	AOR	95% CI	p-value
Asthma	1.30	1.11, 1.52	<0.001	0.99	0.84, 1.16	0.882
Back pain	1.97	1.79, 2.16	<0.001	1.37	1.25, 1.51	<0.001
Brain injury ^a	14.95	12.60, 17.73	<0.001	8.80	7.37, 10.50	<0.001
Cancer	1.59	1.38, 1.83	<0.001	1.40	1.21, 1.62	<0.001
CHF	1.78	1.45, 2.19	<0.001	1.31	1.06, 1.61	0.011
COPD	2.04	1.79, 2.33	<0.001	1.39	1.22, 1.59	<0.001
Diabetes	1.18	1.04, 1.34	0.008	0.98	0.87, 1.12	0.788
Epilepsy	3.27	2.35, 4.54	<0.001	1.77	1.27, 2.48	<0.001
HIV/AIDS	3.39	2.17, 5.27	<0.001	2.14	1.36, 3.36	<0.001
Heart disease	1.19	1.02, 1.37	0.023	0.89	0.77, 1.04	0.135
Hypertension	1.37	1.24, 1.52	<0.001	0.99	0.90, 1.11	0.968
Migraine	2.82	2.29, 3.49	<0.001	1.85	1.50, 2.30	<0.001
Multiple sclerosis	1.85	0.99, 3.48	0.055	1.27	0.67, 2.40	0.460
Osteoporosis	1.21	0.90, 1.62	0.216	0.93	0.69, 1.25	0.633
Parkinson's	1.87	1.20, 2.91	0.006	1.10	0.70, 1.73	0.666
Psychogenic pain	3.20	2.21, 4.62	<0.001	0.97	0.67, 1.41	0.888
Renal disorder	1.48	1.26, 1.74	<0.001	1.07	0.91, 1.22	0.407
Sleep disorders	3.66	3.30, 4.05	<0.001	2.08	1.87, 2.31	<0.001
Stroke	1.97	1.58, 2.47	<0.001	1.25	0.99, 1.56	0.058

Note: Boldface indicates statistical significance ($p < 0.05$). Logistic regression models are conditional on site.

^aBrain injury denotes traumatic brain injury.

CHF, congestive heart failure; COPD, chronic obstructive pulmonary disorder; Diabetes, diabetes mellitus; Parkinson's, Parkinson's disease.

Table 4
Risk of Suicide Due to Increasing Numbers of Physical Health Conditions

# of Conditions	Controls (n=267,400)		Cases (n=2,674)		AOR (Adjusted for sex and age)			AOR (Adjusted for sex, age, mental health and substance use diagnoses)			
	% (n)	% (n)	OR	95% CI	p-value	OR	95% CI	p-value	AOR	95% CI	p-value
0	64.0 (171,044)	38.3 (1,024)	--	--	--	--	--	--	--	--	--
1	20.5 (54,812)	23.6 (630)	1.92	1.74, 2.13	<0.001	1.72	1.55, 1.91	<0.001	1.20	1.08, 1.33	<0.001
2	15.5 (41,544)	38.2 (1,020)	4.12	3.77, 4.50	<0.001	3.11	2.80, 3.45	<0.001	1.70	1.52, 1.89	<0.001

Note: Boldface indicates statistical significance ($p < 0.05$). Logistic regression models are conditional on site.