

Chronic Physical Conditions and Their Association With First Onset of Suicidal Behavior in the World Mental Health Surveys

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Objective: To investigate the association of a range of temporally prior physical conditions with the subsequent first onset of suicidal ideation, plans, and attempts in large, general population, cross-national sample. The associations between physical conditions and suicidal behavior remain unclear due to sparse data and varied methodology. **Methods:** Predictive associations between 13 temporally prior physical conditions and first onset of suicidal ideation, plans, and attempts were examined in a 14-country sample ($n = 37,915$) after controlling for demographic, socioeconomic, and psychosocial covariates, with and without adjustment for mental disorders. **Results:** Most physical conditions were associated with suicidal ideation in the total sample; high blood pressure, heart attack/stroke, arthritis, chronic headache, other chronic pain, and respiratory conditions were associated with attempts in the total sample; epilepsy, cancer, and heart attack/stroke were associated with planned attempts. Epilepsy was the physical condition most strongly associated with the suicidal outcomes. Physical conditions were especially predictive of suicidality if they occurred early in life. As the number of physical conditions increased, the risk of suicidal outcomes also increased, however the added risk conferred was generally smaller with each additional condition. Adjustment for mental disorders made little substantive difference to these results. Physical conditions were equally predictive of suicidality in higher and lower income countries. **Conclusions:** The presence of physical conditions is a risk factor for suicidal behavior even in the absence of mental disorder. **Key words:** suicidal behavior, physical conditions, mental disorders.

HIV/AIDS = human immunodeficiency virus/acquired immune deficiency syndrome; **WMH** = World Mental Health; **OR** = odds ratio; **CI** = confidence interval; **DSM-IV** = Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition.

INTRODUCTION

There have been many studies on the association of physical conditions with suicide mortality (1–3). Although results vary, collectively they suggest that cancer, human immunodeficiency virus (HIV)/acquired immune deficiency syndrome (AIDS), renal disease, and some neurological conditions (Huntington's disease, stroke, epilepsy, multiple sclerosis, spinal cord lesions) are the most strongly associated with completed suicide. Most of these studies (1,2) have not determined whether these associations are independent of mental disorders, and it is assumed by some researchers (2) that mental

disorders explain the link between physical conditions and suicide. Of the mortality studies that have controlled for mental disorders, some (3–5) have found cancer to be independently associated with completed suicide, but findings are conflicting for the independent association of other conditions with suicide (3,4), and even for cancer, an independent association with suicide has not been reliably found (6).

Prior suicide attempts are one of the strongest predictors of completed suicide (7,8), making suicidal behavior (ideation, plans, attempts) a useful outcome to study. Additionally, suicidal behavior occurs at a higher base rate than suicide death and allows for interview of the person making the attempt, making it more feasibly studied in the general population. However, the literature on the association of physical conditions with suicidal behavior is limited. It is also highly variable in methodology; a variability that spans whether ideation or attempts are the outcome investigated (9–11); the age range of the study population (12,13); whether one specific physical condition (14–17), a range of specific conditions (9), or any nonspecific physical condition is studied (18); and which covariates are statistically controlled for (including whether mental disorder is controlled for). Conclusions about the associations between physical conditions and suicidal behavior are accordingly very difficult to draw.

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A complete list of WMH publications can be found at <http://www.hcp.med.harvard.edu/wmh/>.

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The present study extends the prior literature on the association between physical conditions and suicidal behavior through an investigation that is novel in five ways. First, we investigate the association of a range of temporally prior physical conditions with the subsequent first onset of suicidal ideation, plans, and attempts in large, general population, cross-national sample. Second, we adjust for a wider range of correlates than prior studies, and we provide estimates both with and without control for *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (DSM-IV) diagnosed mental disorders. Third, we provide new information on the association between both number and type of physical condition and suicide outcomes, and we take their mutual influence into account in final estimates. Fourth, we examine associations between physical conditions and suicidality across the life course. Fifth, we investigate whether associations vary across lower and higher income countries, prompted by the suggestion that, in developing countries, factors other than mental disorders (such as physical illness) may more strongly predict suicidal behavior (19).

METHODS

Samples and Procedures

This study uses data from 14 of the World Mental Health (WMH) surveys: Colombia, Mexico, United States, Shenzhen (China), Japan, New Zealand, Belgium, France, Germany, Italy, The Netherlands, Romania, Spain, Israel. The World Bank (2008) classifies Belgium, France, Germany, Israel, Italy, Japan, The Netherlands, New Zealand, Spain, and the United States as high income countries; Mexico, Romania, China, and Colombia as middle or low income countries. A stratified multistage clustered area probability sampling strategy was used to select adult respondents (age, ≥ 18 years) in most WMH countries. All interviews were carried out face-to-face by trained lay interviewers between 2001 to 2004. Survey samples ranged from 2357 in Romania to 12,790 in New Zealand. Ten of the 14 surveys were based on nationally representative household samples, whereas Colombia, Mexico, and Shenzhen were based on nationally representative household samples in urbanized areas. The survey response rates ranged from 45.9% (France) to 87.7% (Colombia), with a weighted average response rate across all countries of 67.7% (20,21) for sample and survey characteristics.

Internal subsampling was used to reduce respondent burden and average interview time by dividing the interview into two parts. Except for Israel and Romania, where all respondents were administered the full interview, all respondents completed Part 1, which included the core diagnostic assessment of mental disorders and suicidal behavior. All Part 1 respondents who met the lifetime criteria for any mental disorder and a probability sample of other respondents were administered Part 2, which assessed physical conditions and other correlates and risk factors. Part 2 respondents were weighted by the inverse of their probability of selection for Part 2 of the interview to adjust for differential sampling. Analyses in this paper are based on the weighted Part 2 sample ($n = 37,915$). Additional weights were used to adjust for differential probabilities of selection within households, to adjust for nonresponse, and to match the samples to population sociodemographic distributions. Measures taken to ensure interviewer and data accuracy and cross-national consistency are described elsewhere (21,22). All respondents provided informed consent, and procedures for protecting respondents were approved and monitored for compliance by the Institutional Review Boards in each country (21).

Measures—Mental Disorders

All surveys used the WMH survey version of the World Health Organization Composite International Diagnostic Interview (now Composite International Diagnostic Interview 3.0) (22), a fully structured interview, to assess lifetime history of mental disorders. Disorders were assessed, using the

definitions and criteria of the DSM-IV. The mental disorders adjusted for in this paper include anxiety disorders (panic disorder, agoraphobia, specific phobia, social phobia, posttraumatic stress disorder, generalized anxiety disorder, separation anxiety disorder); mood disorders (major depressive disorder, dysthymia, bipolar disorder); substance use disorders (alcohol abuse and dependence, drug abuse and dependence); and impulse control disorders (attention deficit/hyperactivity disorder, conduct disorder, intermittent explosive disorder, oppositional defiant disorder). Suicidal behaviors were assessed with the WMH-Composite International Diagnostic Interview Suicidality Module (22). This assesses lifetime occurrence and age-of-onset of suicide behavior, classified here into five outcomes: 1) suicide attempt in the total sample; 2) suicide ideation in the total sample; 3) suicide plan among ideators; 4) suicide attempt among ideators with a plan (planned attempt); and 5) suicide attempt among ideators without a plan (unplanned attempt). Physical conditions were assessed using a checklist adapted from the U.S. Health Interview Schedule. Respondents were asked: "Have you ever had ... arthritis or rheumatism; chronic back or neck problems; frequent or severe headaches; any other chronic pain; seasonal allergies like hay fever; a stroke; a heart attack?" They were then asked: "Did a doctor or other health professional ever tell you that you had ... heart disease; high blood pressure; asthma; tuberculosis; any other chronic lung disease (like chronic obstructive pulmonary disease or emphysema); diabetes or high blood sugar; an ulcer in the stomach or intestine; HIV infection or AIDS; epilepsy or seizures; cancer?" For all conditions reported, respondents were asked how old they were when they were first diagnosed with the condition or first had the condition. For this paper, heart attack and stroke were aggregated, as were respiratory conditions (asthma, chronic obstructive pulmonary disease, emphysema, tuberculosis). HIV/AIDS could not be included due to small numbers. Assessment of the variables that were used as controls in the multivariate models (childhood adversities, lifetime traumatic events, parental psychopathology) is detailed elsewhere (21).

Statistical Analysis

Discrete-time survival analyses (23) with person-year as the unit of analysis were used to test the associations between physical conditions and each of the suicidal behavior outcomes. For these analyses, a person-year data set was created in which each year in the life of each respondent up to and including the age of onset of suicidal behavior was treated as a separate observational record with the year of first onset coded 1 and earlier years coded 0 on a dichotomous outcome variable. Predictors were recorded either with the same values from year to year (time invariant predictors, e.g., gender) or with dichotomous values that can change from year to year (time-varying predictors). Physical conditions were coded 1 in the year after the year of first onset and 0 in earlier years, e.g., if asthma started at age 12, it would be coded 1 to predict onsets of suicide starting at age 13 and would remain coded positive throughout the remainder of the life course. Person-years subsequent to the first onset of the outcome were censored. Logistic regression analysis were used to analyze these data with the survival coefficients estimating the risk of the onset of the suicidal behavior exponentiated and interpreted as odds and odds ratios.

A series of multivariate models were developed, including a series of dummy predictor variables for physical conditions plus control variables. Models control for: person-years (5-year intervals); countries; demographics (sex, age, time-varying education, time-varying marriage); interactions between person-years (three dichotomous dummies representing early, middle, and later years in the person's life) and demographic variables; parental psychopathology; childhood adversities; lifetime traumatic events; and in some models, type of physical condition; number of physical conditions; and mental disorders.

The first multivariate model was an additive model in which all physical conditions were entered simultaneously, providing an estimate of the association of type of physical condition with the outcome adjusting for the other physical conditions plus the control variables. The second multivariate additive model included a series of predictor variables for number of physical conditions (e.g., one such variable for respondents who experienced exactly one physical condition, another for respondents who experienced exactly two conditions), as well as the control variables. The third multivariate model, a

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nonadditive model, included predictors for both number and type of physical condition, thus adjusting for their mutual influence (in addition to the control variables), and allowing for the nonadditive effects of number. This nonadditive multivariate model provided a better fit for the data than the additive models (details of model fitting available on request). This best-fitting multivariate model was then rerun, including controls for the mental disorders specified above, in addition to the other controls included in the earlier models. As the WMH data are both clustered and weighted, the design-based Taylor series linearization (24) implemented in the SUDAAN software system (25) was used to estimate standard errors and evaluate the statistical significance of coefficients.

RESULTS

Associations Between Type of Physical Condition and Suicidal Behavior

Multivariate estimates for the associations between each type of physical condition and the outcomes, adjusted for controls and for other physical conditions, are provided in Table 1. The significant effects observed for attempts ($\chi^2 = 49.1$) and ideation ($\chi^2 = 176.5$) in the total sample indicate that there were significant differences among types of physical conditions in their associations with these outcomes. Most of the physical conditions were associated with ideation, with epilepsy the most strongly associated (odds ratio [OR], 2.1), but most conditions were not associated with predicting which ideators go on to make plans or attempts (epilepsy is the exception to this with an OR of 3.3 for a planned attempt).

Association Between Number of Physical Conditions and Suicidal Behavior

Table 2 shows associations between number of physical conditions and suicidality, without considering type of physical conditions. The general pattern for the first two outcomes (attempts and ideation in the total sample) is that risk of the outcome increased with increasing number of physical conditions (as indicated by the significant χ^2 values of 37.5 and 124.3, respectively). However, this model did not take into account type of condition, and it assumed an additive relationship between number of conditions and the suicide outcome.

Associations Between Physical Conditions and Suicidal Behavior, Controlling for Number and Type

The multivariate model presented in Table 3 is a nonadditive model that included both type and number of physical conditions and considered their independent associations with the outcomes. Type of physical condition remained significant in this model after controlling for number of physical conditions ($\chi^2 = 145.2$), and there was significant variability among physical condition types in their associations with ideation ($\chi^2 = 64.1$). All physical conditions with the exception of cancer, diabetes, and allergies were significantly associated with ideation in the total sample after controlling for number of physical conditions. Epilepsy remained the most strongly associated with both ideation (OR,

TABLE 1. Multivariate Model^a for Associations Between Each Type of Physical Condition and Suicidal Behavior, Controlling for Other Types (All Countries Combined)

	Lifetime Attempts in Total Sample OR (95% CI)	Lifetime Ideation in Total Sample OR (95% CI)	Lifetime Plans Among Ideators OR (95% CI)	Lifetime Attempts Among Ideators With a Plan OR (95% CI)	Lifetime Attempts Among Ideators Without a Plan OR (95% CI)
Cancer	1.3 (0.8–2.2)	0.9 (0.6–1.3)	0.9 (0.5–1.6)	1.9 (0.9–4.1)	1.2 (0.5–2.9)
Cardiovascular					
Heart disease	0.9 (0.6–1.4)	1.2 (0.8–1.6)	0.8 (0.5–1.4)	0.6 (0.3–1.2)	1.3 (0.7–2.5)
High blood pressure	1.3 (1.0–1.8)	1.1 (0.9–1.3)	1.0 (0.8–1.4)	1.1 (0.7–1.8)	1.5 (0.9–2.4)
Heart attack or stroke	1.7* (1.0–2.9)	1.5* (1.1–2.1)	1.0 (0.6–1.7)	2.0 (0.8–5.3)	1.1 (0.4–3.0)
Diabetes	0.9 (0.5–1.7)	1.0 (0.7–1.4)	0.6 (0.4–1.2)	0.8 (0.3–2.1)	1.6 (0.7–4.0)
Ulcer	1.0 (0.8–1.4)	1.2 (1.0–1.4)	1.1 (0.8–1.4)	1.0 (0.6–1.9)	1.1 (0.6–2.0)
Musculoskeletal					
Arthritis	1.3 (1.0–1.6)	1.2* (1.1–1.5)	1.0 (0.8–1.3)	1.0 (0.7–1.5)	1.1 (0.7–1.6)
Back and neck pain	0.9 (0.8–1.2)	1.2* (1.1–1.3)	0.9 (0.8–1.1)	0.7* (0.5–0.9)	0.9 (0.6–1.2)
Headache	1.4* (1.1–1.6)	1.6* (1.4–1.7)	1.0 (0.8–1.1)	0.9 (0.7–1.2)	0.9 (0.6–1.1)
Other chronic pain	1.5* (1.2–1.9)	1.2* (1.0–1.4)	1.0 (0.8–1.3)	0.9 (0.6–1.3)	1.9* (1.2–3.0)
Respiratory					
Allergies	0.9 (0.8–1.1)	0.9 (0.8–1.0)	0.8 (0.7–1.0)	0.7 (0.5–1.0)	1.0 (0.7–1.4)
Other respiratory	1.3* (1.0–1.6)	1.3* (1.1–1.5)	1.2 (1.0–1.5)	1.1 (0.7–1.5)	1.4 (0.9–2.0)
Epilepsy	— ^b	2.1* (1.1–4.1)	1.2 (0.5–2.8)	3.3* (1.1–10.4)	— ^b
χ^2	49.1 (<.001)*	176.5 (<.001)*	10.1 (.69)	22.1 (.05)	14.5 (.27)
Significance test for type of condition					

* Significant at the .05 level, two-sided test.

^a Models include all physical conditions and control for person-years (5-yr intervals), countries, demographics (sex, age, time-varying education, time-varying marriage), interactions between person-years (three dichotomous dummies representing early, middle, and later years in the person's life) and demographic variables; parental psychopathology; parental suicide; childhood adversities; lifetime traumatic events.

^b Condition not included in model due to small cell size.

OR = odds ratio; CI = confidence interval.

TABLE 2. Multivariate Model^a for Associations Between Number of Physical Conditions and Suicidal Behavior (All Countries Combined)

Number of Chronic Conditions	Lifetime Attempts in Total Sample OR (95% CI)	Lifetime Ideation in Total Sample OR (95% CI)	Lifetime Plans Among Ideators OR (95% CI)	Lifetime Attempts Among Ideators With a Plan OR (95% CI)	Lifetime Attempts Among Ideators Without a Plan OR (95% CI)
1	1.5* (1.3–1.7)	1.5* (1.4–1.7)	1.0 (0.8–1.2)	1.1 (0.8–1.5)	0.9 (0.7–1.2)
2	1.4* (1.2–1.8)	1.5* (1.3–1.7)	0.9 (0.8–1.2)	0.7 (0.5–1.0)	1.2 (0.9–1.7)
3	1.5* (1.2–2.0)	1.7* (1.5–2.0)	0.9 (0.7–1.2)	0.6* (0.4–1.0)	1.1 (0.7–1.7)
4	1.3 (0.9–2.0)	2.0* (1.6–2.7)	0.8 (0.6–1.2)	0.6 (0.4–1.1)	0.8 (0.4–1.6)
5+	2.9* (1.7–4.9)	2.5* (1.8–3.7)	1.0 (0.7–1.4)	0.7 (0.4–1.4)	3.6* (1.7–7.7)
Significance test for number of physical conditions	37.5 (<.001)*	124.3 (<.001)*	1.4 (.92)	12.8 (.026)*	13.5 (.019)*

* Significant at the .05 level, two-sided test.

^a Models control for person-years (5-yr intervals), countries, demographics (sex, age, time-varying education, time-varying marriage), interactions between person-years (three dichotomous dummies representing early, middle, and later years in the person’s life) and demographic variables; parental psychopathology; parental suicide; childhood adversities; lifetime traumatic events.

OR = odds ratio; CI = confidence interval.

TABLE 3. Multivariate, Nonadditive Model^a for Associations Between Each Type of Physical Condition and Suicidality, Controlling for Other Types and Number of Physical Conditions; Unadjusted for Mental Disorder (All Countries Combined)

	Lifetime Attempts in Total Sample OR (95% CI)	Lifetime Ideation in Total Sample OR (95% CI)	Lifetime Plans Among Ideators OR (95% CI)	Lifetime Attempts Among Ideators With a Plan OR (95% CI)	Lifetime Attempts Among Ideators Without a Plan OR (95% CI)
Cancer	1.6 (1.0–2.6)	1.1 (0.7–1.7)	0.9 (0.5–1.6)	2.5* (1.1–5.4)	0.9 (0.3–2.2)
Cardiovascular					
Heart disease	1.0 (0.6–1.7)	1.5* (1.1–2.0)	0.9 (0.5–1.6)	0.7 (0.3–1.5)	1.0 (0.5–2.1)
High blood pressure	1.6* (1.2–2.3)	1.3* (1.1–1.7)	1.1 (0.8–1.6)	1.5 (0.9–2.4)	1.2 (0.7–2.2)
Heart attack or stroke	2.1* (1.2–3.7)	1.9* (1.3–2.7)	1.0 (0.6–1.7)	2.7* (1.0–7.4)	0.8 (0.3–2.3)
Diabetes	1.1 (0.6–2.1)	1.3 (0.9–1.8)	0.7 (0.4–1.2)	1.1 (0.4–2.7)	1.3 (0.5–3.3)
Ulcer	1.2 (0.8–1.8)	1.5* (1.2–1.8)	1.2 (0.9–1.6)	1.3 (0.7–2.5)	0.9 (0.5–1.8)
Musculoskeletal					
Arthritis	1.5* (1.1–2.0)	1.6* (1.3–1.9)	1.1 (0.8–1.5)	1.3 (0.8–2.1)	0.8 (0.5–1.3)
Back and neck pain	1.2 (0.9–1.5)	1.5* (1.3–1.7)	1.0 (0.8–1.3)	0.9 (0.6–1.4)	0.7 (0.5–1.2)
Headache	1.6* (1.3–2.0)	1.9* (1.6–2.1)	1.0 (0.8–1.3)	1.2 (0.8–1.7)	0.7 (0.5–1.1)
Other chronic pain	1.8* (1.4–2.4)	1.5* (1.3–1.9)	1.1 (0.8–1.5)	1.1 (0.7–1.8)	1.5 (0.9–2.4)
Respiratory					
Allergies	1.1 (0.8–1.3)	1.1 (1.0–1.2)	0.9 (0.7–1.1)	0.9 (0.6–1.4)	0.9 (0.6–1.3)
Other respiratory	1.5* (1.2–2.0)	1.6* (1.4–1.9)	1.3 (1.0–1.7)	1.4 (0.9–2.3)	1.1 (0.7–1.7)
Epilepsy	— ^b	2.6* (1.3–5.1)	1.2 (0.5–3.0)	4.5* (1.3–15.2)	— ^b
Number of physical conditions					
2 conditions	0.8 (0.6–1.0)	0.7* (0.6–0.8)	0.9 (0.7–1.2)	0.6* (0.3–1.0)	1.5 (0.9–2.7)
3 conditions	0.6* (0.4–0.9)	0.5* (0.4–0.7)	0.9 (0.5–1.4)	0.4 (0.2–1.0)	1.4 (0.6–3.3)
4 conditions	0.3* (0.2–0.6)	0.4* (0.3–0.6)	0.7 (0.4–1.4)	0.3* (0.1–0.9)	1.1 (0.3–4.0)
≥5 conditions	0.4 (0.2–1.1)	0.3* (0.1–0.5)	0.8 (0.3–2.0)	0.3 (0.1–1.4)	5.1 (1.0–26.6)
13 <i>df</i> group χ^2 significance test for 13 types	55.4 (<.001)*	145.2 (<.001)*	10.0 (.69)	22.2 (.05)	12.2 (.43)
12 <i>df</i> χ^2 significance test for difference between types	24.2 (.012)*	64.1 (<.001)*	8.9 (.71)	20.2 (.06)	12.0 (.36)
χ^2 significance test for number of conditions	13.7 (.008)*	27.4 (<.001)*	1.4 (.84)	6.4 (.17)	8.9 (.06)

* Significant at the .05 level, two-sided test.

^a Models control for person-years (5-yr intervals), countries, demographics (sex, age, time-varying education, time-varying marriage), interactions between person-years (three dichotomous dummies representing early, middle, and later years in the person’s life) and demographic variables; parental psychopathology; parental suicide; childhood adversities; lifetime traumatic events; type of physical condition; number of physical conditions.

^b Condition not included in model due to small cell size.

OR = odds ratio; CI = confidence interval.

2.6) and with planned attempts (OR, 4.5). Cancer and heart attack/stroke were also significantly associated with planned attempts (ORs, 2.5 and 2.7, respectively).

Number of physical conditions remained significantly associated with ideation in the total sample after controlling for type ($\chi^2 = 27.4$), but in contrast with the previous model, the

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ORs associated with number of physical conditions were all <1.0 and became smaller as the number of physical conditions increased. This indicates that, although the odds of suicide ideation increased with increasing number of physical conditions, they did so at a significantly decreasing rate. For example, the interaction OR of 0.8 for the association of two conditions with attempts in the total sample (first column of data) indicates that the joint association of two conditions was 80% of what it would be in an additive model. For three conditions, it was 60% of the additive effect, and so on. The same pattern was evident with attempts in the total sample.

It is notable that the ORs associated with individual physical condition types in Table 3 are higher than the corresponding ORs in the multivariate model shown in Table 1. This is because the additive model shown in Table 1 did not take into account the subadditive effect of number of conditions, leading to an underestimation of the effects of the individual physical conditions.

Adjustment for Mental Disorders

Adjustment for a wide range of DSM-IV mental disorders did not make a great deal of difference to the associations

between physical conditions and suicidal behaviors (Table 4), with most ORs reducing only slightly in magnitude. All physical conditions that were significantly associated with attempts and ideation in the total sample before adjustment for mental disorders remained significantly associated with these outcomes post mental disorder adjustment. However, of the three conditions that were significantly associated with planned attempts before adjustment for mental disorders, only epilepsy remained significant after adjustment, with cancer and heart attack/stroke dropping to marginal significance.

Interactions Between Physical Conditions and When in the Life Course the Suicide Behavior Occurs

Analyses that tested for interactions between each physical condition and whether the suicide outcome occurred in early, midlife, or later life (for the two outcomes of ideation and attempts in the total sample) found a common pattern across most physical conditions of the association with both ideation and attempts being strongest in the youngest third with the suicide outcome relative to the oldest third (data not shown, available on request). For example, there was a significant

TABLE 4. Multivariate, Nonadditive Model^a for Associations Between Each Type of Physical Condition and Suicidality, Controlling for Other Types and Number of Physical Conditions; Adjusted for Mental Disorder (All Countries Combined)

	Lifetime Attempts in Total Sample OR (95% CI)	Lifetime Ideation in Total Sample OR (95% CI)	Lifetime Plans Among Ideators OR (95% CI)	Lifetime Attempts Among Ideators With a Plan OR (95% CI)	Lifetime Attempts Among Ideators Without a Plan OR (95% CI)
Cancer	1.2 (0.6–2.5)	1.1 (0.7–1.6)	0.9 (0.5–1.6)	2.3 (1.0–5.2)	0.8 (0.3–2.2)
Cardiovascular					
Heart disease	1.0 (0.6–1.8)	1.4* (1.0–1.9)	0.9 (0.5–1.6)	0.8 (0.4–1.6)	1.0 (0.5–2.0)
High blood pressure	1.5* (1.1–2.1)	1.3* (1.0–1.5)	1.1 (0.8–1.6)	1.4 (0.9–2.3)	1.2 (0.7–2.2)
Heart attack or stroke	1.9* (1.1–3.5)	1.9* (1.3–2.8)	1.0 (0.6–1.6)	2.7 (0.9–8.0)	0.9 (0.3–2.3)
Diabetes	1.1 (0.6–2.1)	1.3 (0.9–1.8)	0.6 (0.3–1.2)	1.0 (0.4–2.5)	1.4 (0.6–3.3)
Ulcer	1.2 (0.8–1.7)	1.4* (1.1–1.7)	1.1 (0.8–1.5)	1.2 (0.6–2.3)	1.0 (0.5–2.0)
Musculoskeletal					
Arthritis	1.5* (1.1–1.9)	1.5* (1.3–1.8)	1.1 (0.8–1.5)	1.3 (0.8–2.1)	0.8 (0.5–1.3)
Back and neck pain	1.0 (0.8–1.3)	1.4* (1.2–1.6)	1.0 (0.8–1.2)	0.8 (0.5–1.3)	0.7 (0.5–1.2)
Headache	1.4* (1.1–1.7)	1.6* (1.5–1.9)	1.0 (0.8–1.2)	1.1 (0.8–1.7)	0.8 (0.5–1.1)
Other chronic pain	1.6* (1.2–2.0)	1.3* (1.1–1.7)	1.0 (0.8–1.4)	1.1 (0.6–1.8)	1.5 (0.9–2.4)
Respiratory					
Allergies	1.0 (0.8–1.3)	1.1 (0.9–1.2)	0.9 (0.7–1.1)	0.9 (0.6–1.3)	0.8 (0.6–1.3)
Other respiratory	1.5* (1.2–1.9)	1.5* (1.3–1.8)	1.3 (1.0–1.6)	1.4 (0.9–2.3)	1.1 (0.7–1.7)
Epilepsy	— ^b	2.2* (1.2–4.3)	1.3 (0.5–3.0)	4.4* (1.2–16.2)	— ^b
Number of physical conditions					
2 conditions	0.8 (0.6–1.0)	0.7* (0.6–0.8)	0.9 (0.7–1.2)	0.6 (0.4–1.0)	1.5 (0.8–2.6)
3 conditions	0.6* (0.4–0.9)	0.5* (0.4–0.7)	0.9 (0.5–1.4)	0.5 (0.2–1.1)	1.4 (0.6–3.3)
4 conditions	0.3* (0.2–0.6)	0.4* (0.3–0.6)	0.7 (0.4–1.4)	0.3* (0.1–0.9)	1.0 (0.3–3.8)
≥5+ conditions	0.5 (0.2–1.3)	0.3* (0.2–0.5)	0.8 (0.3–1.9)	0.4 (0.1–1.7)	4.9 (0.9–25.5)
13 <i>df</i> χ^2 significance test for 13 types	39.5 (<.001)*	100.5 (<.001)*	10.9 (.62)	22.2 (.05)	12.2 (.43)
12 <i>df</i> χ^2 test for difference between types	22.1 (.024)*	50.1 (<.001)*	9.8 (.63)	21.7 (.040)*	12.3 (.34)
χ^2 significance test for number	14.9 (.005)*	25.8 (<.001)*	1.3 (.86)	5.8 (.22)	9.1 (.06)

* Significant at the .05 level, two-sided test.

^a Models control for person-years (5-yr intervals), countries, demographics (sex, age, time-varying education, time-varying marriage), interactions between person-years (three dichotomous dummies representing early, middle, and later years in the person's life) and demographic variables; parental psychopathology; parental suicide; childhood adversities; lifetime traumatic events; type of physical condition; number of physical conditions; mental disorders.

^b Condition not included in model due to small cell size.

OR = odds ratio; CI = confidence interval.

interaction between heart disease and life course in the association with suicide attempts with an interaction OR of 0.4 for heart disease among the oldest third of those attempting suicide. This indicates that the association in this older group was only 40% of the magnitude of the association in the reference group (the youngest third of suicide attempters). Due to low power, this pattern was only significant for some conditions.

Consistency of Results by Country Income Level

The same models were run separately for pooled high income countries and for pooled low and middle income countries (referred to here as “lower income countries”). When the final multivariate models for these two sets of countries were compared (data not shown, available on request), physical conditions were not, generally speaking, more strongly associated with the suicide outcomes in the lower income countries. One exception to this was arthritis, which was more strongly associated with attempts (OR, 3.4; 95% confidence interval [CI], 2.1–5.7) and ideation (OR, 2.3; 95% CI, 1.6–3.3) in lower income countries than in high income countries (OR, 1.2; 95% CI, 0.8–1.7 for attempts; and OR, 1.4; 95% CI, 1.2–1.7 for ideation). It was more typically the case, however, that associations for individual physical conditions were a little lower in the lower income countries. However, small cell sizes precluded cancer, diabetes, or epilepsy being included in the models in lower income countries.

DISCUSSION

This cross-national study provides several important new findings about the association between physical conditions and subsequent first onset of suicidal behavior. First, after accounting for both type and number of physical conditions, most physical conditions investigated were associated with suicidal ideation in the total sample. Second, high blood pressure, heart attack/stroke, arthritis, chronic headache, other chronic pain, and respiratory conditions were associated with attempts in the total sample; epilepsy, cancer, and heart attack/stroke were associated with planned attempts. Third, epilepsy was the physical condition most strongly associated with suicidal behavior. Fourth, having a greater number of physical conditions was associated with increasing risk of suicidal outcomes but at a decreasing rate. Fifth, the association between physical conditions and suicide outcomes tended to be more pronounced for younger people. Sixth, there were few substantive differences in results across high and lower income countries. Seventh and finally, these results were not explained by the presence of mental disorders, as adjustment for mental disorders made little difference overall to results.

It is interesting that, although this study included adjustment for a wider range of diagnosed mental disorders than any prior study, we found that this did not greatly influence the significance of associations between physical conditions and suicidal behavior. This contrasts with prior population studies (9,10,12,13,15) that have typically found that adjustment for mental disorder has dramatically reduced the number of phys-

ical conditions significantly associated with the suicidal outcome. Although there are many methodological differences between the current study and prior reports, we would suggest three differences that may best account for this particular discrepancy in results.

First, the dating information on onset of suicidal behavior contained in the WMH surveys enabled us to study first onset suicidal behavior, in contrast to most cross-sectional surveys where the measure of suicidal behavior is a mix of first onset and recurrent suicidal behavior. This is significant because we know from other WMH analyses that associations between physical conditions and first onset suicidal behavior are considerably stronger than associations between physical conditions and recurrent suicidal behavior (data not shown, available on request). Second, the dating information we have on the onset of physical conditions has enabled us to study temporally prior physical conditions, in contrast to the usual measure of physical conditions in cross-sectional surveys, which is an aggregate of physical conditions that occur before and those that occur after the onset of the suicidal behavior. The likely effect of aggregating physical conditions that can plausibly predict suicidal behavior (because they precede the suicidal outcome) with those that cannot predict suicidal behavior (because they follow the outcome), and where reverse causality is unlikely (suicidal behavior does not obviously lead to physical condition onset) is to attenuate associations between physical conditions and suicidal behaviors. Third, the sample size in this study is larger than prior general population studies, and earlier reports (26) have been criticized for being possibly underpowered to detect associations.

What are the clinical implications of these findings? We found that, regardless of whether people with chronic physical conditions have associated mental disorders, the presence of many physical conditions is a risk factor for suicidal ideation and attempts. This is an important corrective to the view that only those with mental disorders among those with physical conditions contemplate suicide. However, given the low base rate of suicide attempts and the high base rate of chronic physical conditions, and the generally low-to-moderate magnitude of associations we found (with the exception of the risk associated with epilepsy), it is perhaps of more practical import for clinicians to note that it is likely to be people with mental-physical comorbidity who are at greatest risk of suicidal behavior (in that both physical conditions and mental disorders are independently associated with suicidal behaviors), and that this combination in a younger person is of particular concern.

Of the conditions we studied, epilepsy emerged as the most strongly associated with suicidal behavior. This is consistent with earlier research that associates epilepsy with completed suicides (1,2,27). These earlier studies did not control for comorbid mental disorders, but a recent case-control study (28) on a large sample found that epilepsy increased the risk of completed suicides even among those without a history of mental disorders. The authors attributed the association of epilepsy with suicide in that study, which was strongest in the young, to the impact of epilepsy on quality of life (loss of

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driving license, impact on job or career). Other possible contributing explanations to the relatively strong association of epilepsy with suicide and suicidality, even independent of mental disorders, include the stigmatizing impact of epilepsy (29,30), the effects of anticonvulsant medication (which recently attracted a U.S. Food and Drug Administration suicide risk warning) (31,32), and the high rates of subthreshold depressive symptoms in those with epilepsy (33).

Several limitations of this study should be borne in mind when interpreting these results. These data were based on retrospective self-report of the occurrence and timing of suicidal behaviors, mental disorders, and covariates, such as childhood adversity. Reviews (34,35) of the validity of retrospective reports conclude that retrospectively reported events that are clearly operationalized are sufficiently valid to warrant their use, although there is a considerable degree of underreporting and possibly some bias. Bias can result from current mental state influencing recall (36), but as we report associations with and without mental disorders, this is less of an issue in the present study.

The WMH surveys may be biased in terms of sample selection. First, survey nonrespondents might have worse mental and/or physical health than respondents. Second, there could be differential selection out of the population either because of early mortality (e.g., due to suicide, or to a physical condition) or because of such severe impairment that the person cannot be interviewed. These kinds of sample selection bias would generally downwardly bias the strength of the associations between predictors and physical conditions, making these results conservative.

A further limitation is that physical conditions were assessed via self-report. When considering this limitation, it is important to draw a distinction between the medical conditions ascertained by self-report of a physician's diagnosis (e.g., asthma, heart disease, diabetes, cancer) and the self-reported chronic pain conditions (chronic back pain, severe or chronic headache). The presence of the self-reported chronic pain conditions cannot be confirmed by a physician in the same way that the diagnosable medical conditions can, so the self-report nature of these conditions is not a limitation per se. In relation to the validity of self-reported medical conditions, methods research indicates that these generally show good agreement with medical records (37–40). Perhaps a more significant limitation is that only 13 physical conditions could be examined, and it is particularly unfortunate that numbers of WMH respondents reporting HIV/AIDS were too few to include this condition in our analyses. The fact that associations are averaged across all levels of physical condition severity and stages of illness is also a limitation.

These limitations should be balanced against the many strengths of this study, which include its large and representative sample; its comprehensive adjustment for potential explanatory variables, including mental disorder; its investigation of a range of first-onset suicidal behaviors; the use of survival analysis to estimate predictive associations between

temporally prior physical conditions and subsequent suicidal behavior; the novel information it provides on the independent associations of type and number of physical conditions with the outcomes; and the assessment of variation in associations over the life course, and across different countries.

In conclusion, this cross-national study finds that, after adjustment for a wide range of demographic, socioeconomic, and psychosocial covariates, many physical conditions are associated with the subsequent first onset of suicidal ideation; several are associated with the subsequent first onset of suicide attempts and cancer; and heart attack/stroke and epilepsy are associated with planned attempts. These associations are little changed by adjustment for mental disorders. Physical conditions may be an important flag for suicide risk in medical settings, regardless of whether mental disorders are present, although particularly when mental disorders are present.

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