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Social Integration and Suicide Mortality Among Men: 24-Year Cohort Study of U.S. Health Professionals

Alexander C. Tsai, MD, PhD*, Michel Lucas, PhD, RD*, Ayesha Sania, PhD, Daniel Kim, MD, DrPH, and Ichiro Kawachi, MD, PhD

Massachusetts General Hospital, Harvard Medical School, Harvard School of Public Health, and Bouvé College of Health Sciences at Northeastern University, Boston, Massachusetts; Mbarara University of Science and Technology, Mbarara, Uganda; and Centre de Recherche du Centre Hospitalier Universitaire de Québec, Université Laval, Québec City, Québec, Canada.

Abstract

Background—Suicide is a major public health problem. Current thinking about suicide emphasizes the study of psychiatric, psychological, or biological determinants. Previous work in this area has largely relied on surrogate outcomes or samples enriched for psychiatric morbidity.

Objective—To evaluate the relationship between social integration and suicide mortality.

Design—Prospective cohort study initiated in 1988.

Setting—United States.

Participants—34 901 men aged 40 to 75 years.

Requests for Single Reprints: Alexander C. Tsai, MD, PhD, Center for Global Health, Room 1529-E3, Massachusetts General Hospital, 100 Cambridge Street, 15th Floor, Boston, MA 02114; actsai@partners.org.

*Drs. Tsai and Lucas contributed equally to this work.

Current Author Addresses: Dr. Tsai: Center for Global Health, Room 1529-E3, Massachusetts General Hospital, 100 Cambridge Street, 15th Floor, Boston, MA 02114.

Dr. Lucas: Centre de Recherche du Centre Hospitalier Universitaire de Québec, Université Laval, 2875, Boulevard Laurier, Edifice Delta II, Bureau 600, Québec City, Québec G1V 2M2, Canada.

Dr. Sania: Room 911, Building 3, Harvard School of Public Health, 677 Huntington Avenue, Boston, MA 02115.

Dr. Kim: Department of Health Sciences, Bouvé College of Health Sciences at Northeastern University, 360 Huntington Avenue, Robinson Hall Room 316J, Boston, MA 02115.

Dr. Kawachi: Department of Social and Behavioral Sciences, Harvard School of Public Health, 677 Huntington Avenue, Kresge Building, 7th Floor, Boston, MA 02115.

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Author Contributions: Conception and design: A.C. Tsai, I. Kawachi.

Analysis and interpretation of the data: A.C. Tsai, M. Lucas, A. Sania, D. Kim, I. Kawachi.

Drafting of the article: A.C. Tsai.

Critical revision of the article for important intellectual content: A.C. Tsai, M. Lucas, A. Sania, D. Kim, I. Kawachi.

Final approval of the article: A.C. Tsai, M. Lucas, A. Sania, D. Kim, I. Kawachi.

Provision of study materials or patients: I. Kawachi.

Statistical expertise: A.C. Tsai, M. Lucas, A. Sania, I. Kawachi.

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Measurements—Social integration was measured with a 7-item index that included marital status, social network size, frequency of contact, religious participation, and participation in other social groups. Vital status of study participants was ascertained through 1 February 2012. The primary outcome of interest was suicide mortality, defined as deaths classified with codes E950 to E959 from the International Classification of Diseases, Ninth Revision.

Results—Over 708 945 person-years of follow-up, there were 147 suicides. The incidence of suicide decreased with increasing social integration. In a multivariable Cox proportional hazards regression model, the relative hazard of suicide was lowest among participants in the highest (adjusted hazard ratio [AHR], 0.41 [95% CI, 0.24 to 0.69]) and second-highest (AHR, 0.52 [CI, 0.30 to 0.91]) categories of social integration. Three components (marital status, social network size, and religious service attendance) showed the strongest protective associations. Social integration was also inversely associated with all-cause and cardiovascular-related mortality, but accounting for competing causes of death did not substantively alter the findings.

Limitations—The study lacked information on participants' mental well-being. Some suicides could have been misclassified as accidental deaths.

Conclusion—Men who were socially well-integrated had a more than 2-fold reduced risk for suicide over 24 years of follow-up.

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Suicide is a major cause of death in the United States, particularly among men, for whom it is one of the 10 leading causes (1). Suicide rates have increased substantially over the past decade, particularly among middle-aged persons (2). Worldwide, the number of deaths resulting from self-harm increased by more than 30% between 1990 and 2010 (3), with current projections showing a continued increase in its contribution to the global mortality and disease burden (4). In 2000, the most recent year for which data are available, the estimated value of lost productivity due to suicide in the United States exceeded \$60 billion (5).

Much of the discourse around suicide prevention has emphasized the study of its psychiatric, psychological, or biological determinants (6). Yet, as noted in an Institute of Medicine report (7) "If ever a condition begged for an integrated understanding that takes into account biological, clinical, subjective, and social factors, this [suicide] is it." Durkheim (8) advanced an explicitly sociological understanding of suicide, postulating that social integration would be inversely related to suicide. However, because of the lack of high-quality, individual-level, national data, most findings in support of his theory have been derived from the modeling of social integration and suicide at the aggregate level (9).

There have been few prospective studies of social integration and suicide. Although suicide is a leading contributor to premature mortality, especially among men, it is rare relative to the number of persons exposed to its potential risk factors (for example, 36 000 suicides in the United States in a population exceeding 300 million). Individual-level studies, lacking sufficient statistical power to investigate suicide mortality in general population samples, have instead used proxy outcomes, such as suicidal thinking (10) or suicide attempts (11).

Other researchers have studied these proxy outcomes in samples enriched for psychiatric morbidity, such as persons receiving psychiatric care (12). However, in the 21-country World Health Organization World Mental Health Surveys, a substantial proportion of suicidal behaviors occurred in the absence of formally diagnosed mental disorder (13), suggesting that a deeper understanding of factors driving suicide even in generally healthy populations is needed. To address these limitations, we used data from the HPFS (Health Professionals Follow-up Study) to estimate the association between social integration and suicide mortality over 24 years of follow-up.

Methods

Study Design and Setting

The HPFS is an ongoing prospective cohort study of men in the United States who were aged 40 to 75 years when the study was initiated in 1986 (14). Women were not eligible for participation. Of the potentially eligible dentists, optometrists, osteopathic physicians, pharmacists, podiatrists, and veterinarians who were contacted, 51 529 men (33%) responded to the baseline questionnaire. Every 2 years, follow-up questionnaires are mailed to participants to obtain updated information on medical history, diet, lifestyle habits, and other health behaviors. During each survey cycle, up to 7 repeated mailings are used, with the option of a short-form questionnaire for serial nonresponders (15). The combined (long form plus short form) survey follow-up rate for participants enrolled in the baseline cohort exceeds 90% overall, with a response rate to the long-form questionnaire of approximately 70% in any given survey cycle. All participants provided written informed consent. The HPFS and the analysis described here were approved by the Office of Human Research Administration at the Harvard School of Public Health.

Measures

The primary outcome of interest was suicide mortality, assessed continuously during the course of the study between the return of the baseline questionnaire and 1 February 2012. Outcome ascertainment was largely independent of survey administration. In most instances, HPFS staff members were informed of a participant's death by next of kin, through questionnaires serially returned by the U.S. Postal Service, or through reports from participants' professional organizations. The vital status of serial nonresponders was ascertained through the U.S. National Death Index, a method that has been shown to have 98% sensitivity and 100% specificity for ascertainment of deaths (16, 17). Physicians blinded to exposure status reviewed death certificates and hospital or pathology reports to classify individual causes of death. Deaths caused by self-inflicted injuries were classified according to the underlying causes listed on the death certificate. For this study, we specifically examined deaths in the "Suicide and Self-Inflicted Injury" cluster (codes E950 through E959) of the International Classification of Diseases, Ninth Revision (ICD-9). The specific categories of deaths included suicide and self-inflicted poisoning by solid or liquid substances (E950), gases in domestic use (E951), or other gases and vapors (E952); suicide and self-inflicted injury by hanging, strangulation, and suffocation (E953), submersion (E954), firearms and explosives (E955), cutting and piercing instruments (E956), jumping

(E957), or other and unspecified means (E958); and late effects of self-inflicted injury (E959).

The primary exposure of interest was social integration, measured with a 7-item index that included questions about marital status, social network size, frequency of contact with social ties, religious participation, and participation in other social groups (18, 19). The responses to these items yield a total score from 1 to 12 that is typically analyzed as a 4-level categorical variable. Specific procedural details on the construction of the social integration index are available in the Appendix and Appendix Table 1 (available at www.annals.org). At baseline, the index showed acceptable reliability (Cronbach α , 0.72). Additional psychometric analyses (20) and evidence of its construct validity (21, 22) have been described elsewhere. Because the index was not added to the HPFS survey instrument until 1988 (and again in 1996) (23, 24), we considered 1988 as the baseline year in our analysis. The short-form questionnaires mailed to serial nonresponders in 1988 and 1996 were limited to questions about height, weight, smoking status, medical diagnoses, and procedures and did not contain the social integration questions.

Statistical Analysis

All statistical analyses were done with SAS, version 9.2 (SAS Institute, Cary, North Carolina). Each participant contributed person-time beginning from return of the 1988 questionnaire (or, for the analysis of change in social integration described later, return of the 1996 questionnaire) until death or the end of follow-up (1 February 2012), whichever occurred first. To estimate the association between social integration and suicide mortality, we fit a multivariable Cox proportional hazards model to the data (25), using the independent increment model (also described as the Andersen–Gill model) to handle time-updated variables efficiently (26). Under this data structure, a new data record was created for every questionnaire cycle at which a participant was at risk for suicide, with independent variables set to their values at the time the questionnaire was returned. To adjust for potential confounding by age, calendar time, and any potential 2-way interactions between these time scales, we stratified the analysis jointly by age in months at the start of follow-up and calendar year of the questionnaire cycle. The time scale for the analysis was then measured in months since the start of the current questionnaire cycle. We also adjusted our estimates for baseline occupational category (27, 28) and the following time-updated variables: employment status (29); smoking status (30); alcohol intake (31); caffeine intake (32); antidepressant medication use (13, 33); body mass index (34, 35); self-report of a routine physical examination within the previous 2 years; weekly physical activity (36); and history of hypertension, diabetes, hypercholesterolemia, or renal failure (37, 38). To evaluate for departures from the proportional hazards assumption, we used likelihood ratio tests comparing models with and without the interaction terms of age by the specific exposures of interest. To test for linear trends across categories of exposure, we modeled the medians within each category of exposure.

At baseline, the percentage of observations with missing values on the covariates ranged from 0.1% (employment status) to 2.1% (body mass index). After the baseline survey, the percentage of observations with missing values on the covariates ranged from 3.8%

(smoking status) to 19.0% (physical activity). We assumed missingness at random (that is, missingness that did not depend on unobserved data but could depend on observed data) and used the method of multiple imputation to handle missing data. We used the SAS macros PROC MI to impute missing data and PROC MIANALYZE for estimation over 20 imputed data sets.

To assess the extent to which different trajectories of social integration (39) may affect suicide mortality, we fit multivariable Cox proportional hazards regression models with participants classified into 1 of 5 groups on the basis of their levels of social integration in 1988 and 1996: no change in social integration (lowest category [category 1] in 1988 and 1996), decrease in social integration from 1988 to 1996, no change in social integration (intermediate category [category 2 or 3] in 1988 and 1996), increase in social integration from 1988 to 1996, or no change in social integration (highest category [category 4] in 1988 and 1996). In this analysis, 1996 was specified as the baseline year and suicide mortality was assessed during the 16-year period between the return of the 1996 questionnaire and 1 February 2012.

To determine whether our findings were robust to the specific form of the social integration index that was used, we conducted 2 sensitivity analyses. First, assuming the relationship between social integration and suicide mortality was linear across the range of social integration values, we fit a multivariable Cox proportional hazards regression model specifying social integration as a continuous variable. Second, making no assumptions about the specific form of the index, we fit a multivariable Cox proportional hazards regression model with each component of the social integration index specified as a separate variable in order to assess the extent to which specific components of social integration were protective against suicide mortality.

We conducted 2 additional sensitivity analyses to evaluate our findings for potential misclassification or confounding. First, for manner-of-death determinations by the medical examiner for the death certificate, some suicides could have been misclassified as deaths from undetermined causes or as accidental deaths. In the United States, this may be due partly to the requirement of strong corroborative evidence (40) and partly to social pressures, such as familial stigma or concerns about life insurance reimbursement (41). We therefore examined firearm-related suicides (ICD-9 code E955) separately for 2 reasons: Firearms are generally more lethal than other means (42, 43), and firearm-related deaths are less likely to be classified as being from undetermined causes than deaths related to more passive means (44–46), which is the category most susceptible to misclassification (47). Consistent with the latter, although only 3% of deaths due to injuries in the United States are described as deaths from undetermined causes, the percentage of firearm-related deaths described as being from undetermined causes is smaller by an order of magnitude (0.2%) (48). Second, despite our attempts to adjust for important medical history and health behavior variables, our estimates could still be confounded by differences in comorbidity. Severe medical conditions, such as cancer and cardiovascular disease, have been shown to have a positive association with suicide risk (49–51), and poor health has been shown to adversely affect social relationships (39, 52, 53). We therefore refitted the multivariable regression models after excluding participants who reported a history of cancer (specifically,

any type of cancer except for nonmelanoma skin cancer) or a serious cardiovascular condition (specifically, acute myocardial infarction, coronary artery bypass graft surgery, percutaneous transluminal coronary angioplasty, or stroke) at baseline.

Finally, to assess the extent to which competing causes of death could affect our results, we conducted parallel analyses to estimate the association between social integration and 3 major competing outcomes: all-cause mortality, cardiovascular-related mortality (ICD-9 codes 390 to 459), and cancer-related mortality (ICD-9 codes 140 to 208). To formally account for competing causes of death in our analysis, we used the proportional subdistribution hazards regression model proposed by Fine and Gray (54) to estimate the cumulative incidence of suicide. We plotted the cumulative incidence of suicide across different categories of social integration, using a test statistic based on the nonparametric maximum likelihood estimator of the subdistribution hazard to compare cumulative incidence across categories (55). We then used the Fine and Gray model (54) to estimate the differences in cumulative incidence in the presence of covariates, and we expressed these as subdistribution hazard ratios. The results of these sensitivity analyses are reported in the Appendix.

Role of the Funding Source

The study was supported by the National Institutes of Health (NIH) and the Robert Wood Johnson Foundation. The sponsors had no role in study design; collection, analysis, or interpretation of data; or writing of the report.

Results

Of 51 529 men initially enrolled into the HPFS cohort, 34 901 (67.7%) responded to the social integration questions in the 1988 survey. Responders had a lower incidence of suicide than nonresponders over the 24 years of follow-up (21 vs. 30 per 100 000 person-years; Mantel–Haenszel rate ratio, 0.69 [95% CI, 0.52 to 0.92]). Baseline summary statistics for the sample are provided in Table 1. The mean age was 56.6 years (SD, 9.8). Most survey respondents were or had been engaged in dentistry (19 757 [56.6%]) and veterinary (7237 [20.7%]) occupations, and most (26 453 [75.8%]) were working full-time at baseline. The mean social integration index value was 6.6 (SD, 3.1). Most participants were classified into the highest (14 476 [41.5%]) and second-highest (7508 [21.5%]) categories of social integration. Socially isolated (that is, less socially integrated) men were more likely to smoke, consumed more alcohol and caffeine, and were less physically active compared with socially integrated men.

Over 708 945 person-years of follow-up, there were 147 suicides (Table 2). The most frequent means were firearms and explosives (89 [60.5%]); poisoning by solid or liquid substances (20 [13.6%]); and hanging, strangulation, or suffocation (15 [10.2%]). When competing causes of death were accounted for, the cumulative incidence of suicide was highest among the most socially isolated men (Figure). The Gray test (55) rejected the null hypothesis that the cumulative incidence functions were equal across categories ($P < 0.001$). The same pattern was observed in estimates from the multivariable Cox proportional hazards regression models (Table 3). The hazard of suicide was lowest among participants

in the highest (adjusted hazard ratio [AHR], 0.41 [CI, 0.24 to 0.69]) and second-highest (AHR, 0.52 [CI, 0.30 to 0.91]) categories of social integration. A decreasing trend was observed across the categories (P for trend < 0.001). We did not identify any violations of the proportional hazards assumption (P values ranged from 0.21 to 0.82).

For the analysis of changes in social integration from 1988 to 1996, a total of 26 526 participants were included (Table 2). Over these 8 years, the mean change in the social integration index was -0.35 (SD, 2.7), a 5.3% difference relative to the baseline mean value; 1100 participants (4.1%) remained in the lowest category of social integration, 7174 (27.0%) experienced a decrease in social integration, 6299 (23.7%) remained in intermediate categories of social integration, 4707 (17.7%) had an increase in social integration, and 7246 (27.3%) remained in the highest category of social integration. Participants who were categorized as having the highest level of social integration at both time points had a reduced hazard of suicide over subsequent follow-up (AHR, 0.36 [CI, 0.13 to 0.99]), whereas other trajectories of social integration were less protective; a decreasing trend across trajectory categories was observed (P for trend = 0.008) (Table 4).

The sensitivity analyses did not substantively alter our findings. When the social integration index was specified as a continuous variable, each 1-point difference in the index was associated with a 10% lower relative hazard of suicide (AHR, 0.90 [CI, 0.85 to 0.95]). When the components of social integration were examined separately, marital status, social network size, and religious service attendance were identified as having statistically significant protective influences (Table 5). The estimates remained qualitatively similar when we restricted the analysis of outcomes to firearm-related suicides only and when we excluded participants with a baseline history of cancer or a serious cardiovascular condition (Appendix Table 2, available at www.annals.org).

The incidence of nonsuicide mortality greatly exceeded the incidence of suicide mortality in this cohort (Appendix Table 3, available at www.annals.org). To investigate the extent to which competing risks could bias our findings, we examined the associations between social integration and competing causes of death. Participants in higher categories of social integration had lower hazards of all-cause mortality and cardiovascular-related mortality, with decreasing trends across categories (P for trend = 0.018 for all-cause mortality and 0.002 for cardiovascular-related mortality) (Appendix Table 4, available at www.annals.org). When we excluded from estimation participants who reported any history of cancer or serious cardiovascular condition at baseline, the results were qualitatively similar but only the trend test for lower hazards of cardiovascular-related mortality across categories of increasing social integration remained statistically significant (P for trend = 0.004) (Appendix Table 5, available at www.annals.org). Finally, the estimates from the Fine and Gray (54) proportional subdistribution hazards regression models are reported in Appendix Table 6 (available at www.annals.org). Comparison of these subdistribution relative hazard ratios with those reported in Tables 3 to 5 does not reveal substantive differences.

Discussion

In this longitudinal study of 34 901 men in the United States, we found that social integration at baseline was associated with a lower risk for suicide over 24 years of follow-up. The association was statistically significant, large in magnitude, unlikely to be driven by competing mortality risks, and robust to several sensitivity analyses. Previous studies have shown that socially isolated men have a greater incidence of death (23, 24, 56). These studies, however, lacked sufficient follow-up and accrual of events to permit separation of accidental causes of death from suicides, even though their patterning by various sociodemographic indicators is known to diverge substantially (57). Kposowa (58) had access to individual-level, 10-year follow-up data on suicide mortality in a general population sample but was limited to using marital status as the sole measure of social integration. Our study overcame these and other substantive data limitations encountered by previous researchers (10–12) while providing further evidence in support of the importance of social integration to overall health and mental health (59, 60). Different aspects of social integration may matter for suicide risk. Because the empirical weighting scheme of the original social integration index has been criticized (61, 62), we disaggregated the index into its components. We found that elements of both family and religious integration were associated with a lower risk for suicide. Our finding about the protective effects of religious integration is a notable contribution to the literature, given the observation by Koenig and colleagues (63) that only 2 of the 141 studies in their systematic review about religious or spiritual involvement and suicide were based on longitudinal data. Overall, our findings are consistent with those of the study by Breault (64) showing ecological associations among state- and county-level suicide, divorce, and church membership rates and lend further support to the sociological notion that family and religious integration may influence suicide risk.

Our study also provides a unique analysis of how suicide mortality is related to different trajectories of social integration, which are important to consider given that changes in social integration can result in exposure misclassification during follow-up (potentially leading to underestimates of the true association with suicide). A few studies have attempted to understand how these changes affect health (65–69), but none have studied suicide mortality. Our analysis suggests that different trajectories of social integration were associated with suicide, namely that persistently high and increasing levels of social integration had a protective influence. However, the long duration between the assessments of social integration could also have resulted in misclassification. For example, if a study participant was married in 1988, subsequently divorced, and then remarried before 1996, he would have been considered continuously married in our analysis. Depending on the extent of differential misclassification in relation to the outcome, the direction of potential bias is unpredictable.

An important analytic contribution of our analysis is the exclusion of competing mortality risks as a potential explanation for our findings. For example, if socially integrated men were also more likely to die of cardiovascular disease, such early deaths could have depleted the pool of participants at risk for subsequent suicide. Consideration of this possibility is analytically important given that, in the HPFS, the incidence of nonsuicide mortality

exceeded the incidence of suicide mortality by an order of magnitude. However, our analysis suggests that competing risks are unlikely to explain the findings. First, we found that social integration was associated with a reduced hazard of cardiovascular-related mortality, which is consistent with what has previously been reported (23, 24, 70). Therefore, a naive analysis disregarding censoring from competing causes of death would be expected to be biased toward the null, not away from it. Second, our competing-risks analyses confirmed that the cumulative incidence of suicide is lower among more socially integrated men.

Taken together, our findings provide an empirical bridge between a sociological understanding of suicide (8, 9) and prevailing clinical and neurobiological models of suicide and suicidal behaviors (6). In the prototypical “stress-diathesis model” (71), a diathesis is conceptualized as a predisposition toward mental illness that is influenced by genetic, biological, or psychological traits and is activated by stressful life events (72, 73). Acute changes in social integration, such as marital dissolution (74), are frequently viewed as psychosocial stressors that activate a predisposition to suicide, but social integration may also be conceptualized more broadly as contributing to the diathesis itself. The association between social integration and suicide mortality observed in our study suggests that this component of the diathesis may not be entirely latent (73). A deeper investigation of social integration would require information on the exchange of social support as well as more detailed measures of reciprocity, geographic proximity, social network density, or relationship quality (75–77). Regarding relationship quality, we were unable to study the phenomenon of loneliness, a construct closely related to social isolation but defined differently as the subjective perception of inconsistencies between one’s desired and actual social relationships (78). Our analysis was also limited to studying the effects of net, rather than compositional (79, 80), changes in social network size. All of these factors are potentially relevant to a substantive sociological understanding of suicide. Nonetheless, our study extends prior work in its focus on suicide mortality, an unambiguous, terminal outcome that has been largely neglected in psychiatric treatment studies (81).

Interpretation of our findings is subject to several limitations in addition to those already mentioned. First, we had limited ability to adjust for differences in mental health status. The protective effects of social integration on suicide mortality are plausibly mediated by mental health status, given the well-known associations between social integration and emotional well-being (60) and between mood disorders and suicide (13, 33). However, mental health status may also confound the observed relationship between social integration and suicide. For example, as was conceptualized by Coyne (82, 83) in his interactional theory of depression, persons with depressed mood may engage in certain interpersonal behaviors (such as excessive reassurance seeking) that elicit rejection by significant others. Because data on depressed mood were not added to the HPFS until 2002, we had limited ability to account for potential differences in mental health status. However, our regression models were adjusted for antidepressant medication use, which is likely to be a specific indicator of mental health status given the extent to which major depressive disorder is undertreated in the United States (84–86). Adjustment for antidepressant medication use did not alter our findings, which strengthens the plausibility of the observed estimates.

Second, our findings may not be generalizable to other populations. Extending the analysis to more socioeconomically diverse samples of men, to women, or to men or women from a different generation may have yielded different results. That the sample is limited to men employed or previously employed in medically related professions clearly limits the scope of our study's generalizability in many ways. Our estimate of the suicide mortality rate among men in the HPFS over the 24-year follow-up period (21 per 100 000 person-years) is lower than the 2010 national suicide mortality rate of 30.0 to 30.7 per 100 000 person-years among men aged 45 to 59 years (2), suggesting a lower overall level of psychiatric morbidity. If we had access to data on men from a more diverse range of socioeconomic backgrounds, including them in the analysis could have introduced greater possibilities for unobserved confounding, potentially biasing our estimates away from the null. The lack of representation of women in our sample is also a limitation. Not only is the burden of suicide in the United States lower among women (1), the effects of social integration on suicide mortality may also be different among them. Kposowa (58) found that being married and having a higher education level or higher income exerted strongly protective influences against suicide among men but not among women, although Kawachi and Berkman (60) suggested that the quality of relationships and the exchange of social support may be critical effect modifiers to consider. If we had access to data on women (whether in medically related professions or not), our analysis may have shown a null association. Finally, the men enrolled in the study were raised during a period characterized by relative stability in family structure and membership in religious institutions. Since then, the function and authority of family and religious institutions have changed: The median age at first marriage (87) and the rate of divorce (88) have increased, the fertility rate (89) and church attendance among younger generations (90) have decreased, and general population surveys reveal more voluntary and less obligatory attitudes toward marriage and childbearing (91). Parallel analyses of data on men or women from a different generation could yield different results.

Third, as mentioned previously, some suicides could have been misclassified as deaths from undetermined causes or as accidental deaths if incorrect information had been provided by the certifying physician, coroner, or medical examiner for the death certificate. Because ascertainment of suicide based on death certificates is likely to be highly specific but relatively less sensitive, we may have underestimated the number of suicides in the HPFS. This phenomenon is consistent with a more general problem of underreporting of suicides in the United States (7, 92). When we limited our analyses to firearm-related suicides, the estimated associations were nearly identical, suggesting that misclassification was unlikely to have biased our estimates away from the null. In addition, there is no reason to believe that underreporting could have produced the pattern of associations observed in our study. For misclassification to bias our estimates of the association between social integration and suicide away from the null, it would have had to occur disproportionately among socially well-integrated decedents. However, physicians employed by the HPFS to review death certificates and hospital or pathology reports to classify individual causes of death were blinded to exposure status.

In summary, in this 24-year longitudinal study of men in the United States, we found evidence to support the hypothesis that social integration is protective against suicide mortality. Despite the limitations noted, our study lends further support to the development

of targeted social integration interventions aimed at strengthening existing social network structures or creating new ones. Examples include universal prevention strategies, such as those adopted by the U.S. Air Force (93), as well as selective prevention strategies, such as church- and community-based programs for contacting and supporting isolated persons (7). Our use of a general, nonenriched population sample provides important evidence to directly support population-level policies and programs targeting social integration in order to achieve primary suicide prevention (94), especially in light of prior work showing that a sizeable minority of persons who engage in suicidal behaviors do not meet criteria for a mental disorder (13). Given the strength of the observed relationship between social integration and suicide, research to identify its mechanisms may provide important insights into addressing this important public health issue.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Sidebar

Context

Suicide is a major cause of death and is increasing in incidence, especially among middle-aged men. Identifying modifiable risk factors might lead to effective interventions.

Contribution

In a 24-year prospective cohort study, middle-aged men were less likely to commit suicide if they scored highly on measures of social integration. Marriage, frequent attendance at religious services, and having a large social network seemed especially protective.

Caution

Participants were born between 1913 and 1948. Types and amounts of social interaction among men born more recently may differ from those of earlier generations.

Implication

The degree of social integration should be considered in studies of suicide.

—The Editors

Number at risk, *n*

Category 1	2 839	2 520	2 063
Category 2	9 668	8 662	7 126
Category 3	7 310	6 541	5 398
Category 4	14 124	12 807	10 687

Figure 1.
Cumulative incidence of suicide, by social integration category measured in 1988.

Table 1

Baseline Sample Characteristics, by Social Integration Category Measured in 1988*

Characteristic	Overall	Social Integration Category [†]			
		1 (Lowest)	2	3	4 (Highest)
Participants	34 901 (100.0)	2937 (8.4)	9980 (28.6)	7508 (21.5)	14 476 (41.5)
Occupation					
Dentist	19 757 (56.6)	1586 (54.0)	5575 (55.9)	4200 (55.9)	8396 (58.0)
Optometrist	2600 (7.5)	188 (6.4)	659 (6.6)	664 (8.8)	1089 (7.5)
Osteopathic physician	1313 (3.8)	138 (4.7)	434 (4.4)	282 (3.8)	459 (3.2)
Pharmacist	2999 (8.6)	282 (9.6)	880 (8.8)	629 (8.4)	1208 (8.3)
Podiatrist	995 (2.8)	89 (3.0)	315 (3.2)	228 (3.0)	363 (2.5)
Veterinarian	7237 (20.7)	654 (22.3)	2117 (21.2)	1505 (20.1)	2961 (20.5)
Mean age (SD), y	56.6 (9.8)	56.4 (10.0)	56.6 (10.0)	56.5 (9.9)	56.6 (9.6)
Employment status					
Full-time	26 453 (75.8)	2166 (73.8)	7435 (74.5)	5667 (75.5)	11 185 (77.3)
Part-time	2678 (7.7)	260 (8.9)	801 (8.0)	594 (7.9)	1023 (7.1)
Retired	5434 (15.6)	472 (16.1)	1640 (16.4)	1170 (15.6)	2152 (14.9)
Disabled	308 (0.9)	38 (1.3)	92 (0.9)	70 (0.9)	108 (0.8)
Missing	28 (0.1)	1 (0.0)	12 (0.1)	7 (0.1)	8 (0.1)
Smoking status					
Never	15 725 (45.1)	1241 (42.2)	4278 (42.9)	3239 (43.1)	6967 (48.1)
Former	16 150 (46.3)	1360 (46.3)	4778 (47.9)	3565 (47.5)	6447 (44.5)
Current					

Characteristic	Overall	Social Integration Category [†]			
		1 (Lowest)	2	3	4 (Highest)
1–14 cigarettes/d	1053 (3.0)	109 (3.7)	310 (3.1)	258 (3.4)	376 (2.6)
15–24 cigarettes/d	939 (2.7)	86 (2.9)	274 (2.8)	219 (2.9)	360 (2.5)
25 cigarettes/d	951 (2.7)	131 (4.5)	320 (3.2)	210 (2.8)	290 (2.0)
Missing	83 (0.2)	10 (0.3)	20 (0.2)	17 (0.2)	36 (0.3)
Alcohol intake					
None	8075 (23.1)	571 (19.4)	2102 (21.1)	1363 (18.2)	4039 (27.9)
0.1–9.9 g/d	13 612 (39.0)	1104 (37.6)	3853 (38.6)	3106 (41.4)	5549 (38.3)
10–29.9 g/d	9075 (26.0)	809 (27.6)	2648 (26.5)	2104 (28.0)	3514 (24.3)
30 g/d	4139 (11.9)	453 (15.4)	1377 (13.8)	935 (12.5)	1374 (9.5)
Caffeine intake					
Lowest quintile	6992 (20.0)	496 (16.9)	1919 (19.2)	1353 (18.0)	3224 (22.3)
Low	7030 (20.1)	519 (17.7)	1899 (19.0)	1589 (21.2)	3023 (20.9)
Middle	6970 (20.0)	583 (19.9)	1992 (20.0)	1598 (21.3)	2797 (19.3)
High	7028 (20.1)	650 (22.1)	2085 (20.9)	1503 (20.0)	2790 (19.3)
Highest quintile	6881 (19.7)	689 (23.5)	2085 (20.9)	1465 (19.5)	2642 (18.2)
Antidepressant medication use	416 (1.2)	49 (1.7)	135 (1.4)	78 (1.0)	154 (1.1)
Body mass index					
<21 kg/m ²	1338 (3.8)	168 (5.7)	441 (4.4)	243 (3.2)	486 (3.4)
21–22.9 kg/m ²	5020 (14.3)	494 (16.8)	1550 (15.5)	1052 (14.0)	1924 (13.3)
23–24.9 kg/m ²	9590 (28.1)	827 (28.2)	2763 (27.7)	2074 (27.6)	3926 (27.1)
25–27.4 kg/m ²	10 912 (31.3)	798 (27.2)	2997 (30.0)	2424 (32.3)	4693 (32.4)

Characteristic	Overall	Social Integration Category [†]			
		1 (Lowest)	2	3	4 (Highest)
27.5–29.9 kg/m ²	4496 (12.9)	362 (12.3)	1233 (12.4)	933 (12.4)	1968 (13.6)
30 kg/m ²	2809 (8.1)	233 (7.9)	790 (7.9)	616 (8.2)	1170 (8.1)
Missing	736 (2.1)	55 (1.9)	206 (2.1)	166 (2.2)	309 (2.1)
Physical examination in prior 2 y	7691 (22.0)	796 (27.1)	2349 (23.5)	1616 (21.5)	2930 (20.2)
Physical activity					
<3 METs/wk	4137 (11.8)	487 (16.6)	1382 (13.9)	855 (11.4)	1413 (9.8)
3–8.9 METs/wk	6327 (18.1)	566 (19.3)	1829 (18.3)	1409 (18.8)	2523 (17.4)
9–17.9 METs/wk	6626 (19.0)	509 (17.4)	1831 (18.4)	1426 (19.0)	2860 (19.8)
18–26.9 METs/wk	4918 (14.1)	366 (12.5)	1365 (13.7)	1059 (14.1)	2128 (14.7)
27 METs/wk	12 833 (37.0)	1005 (34.2)	3550 (35.6)	2746 (36.6)	5532 (38.2)
Missing	60 (0.2)	4 (0.1)	23 (0.2)	13 (0.2)	20 (0.1)
History of hypertension	8821 (25.3)	791 (26.9)	2596 (26.0)	1889 (25.2)	3545 (24.5)
History of diabetes	1288 (3.7)	124 (4.2)	369 (3.7)	286 (3.8)	509 (3.5)
History of hypercholesterolemia	7785 (22.3)	670 (22.8)	2278 (22.8)	1714 (22.8)	3123 (21.6)
History of renal failure	66 (0.2)	3 (0.1)	14 (0.1)	22 (0.3)	27 (0.2)

MET = metabolic equivalent task.

* Data are numbers (percentages) unless otherwise indicated.

[†] Construction of the social integration index is described in reference 19.

Table 2

Suicides During 1988–2012

Variable	Participants, <i>n</i>	Follow-up, <i>person-years</i>	Suicides Related to Any Cause, <i>n</i>	Incidence Rate, <i>events per 100 000 person-years</i>
All participants in 1988	34 901	708 945	147	21
Social integration category in 1988 [*]				
1 (Lowest)	2937	58 634	23	39
2	9980	201 142	55	27
3	7508	152 023	28	18
4 (Highest)	14 476	297 146	41	14
All participants in 1996	26 526	431 913	81	19
Social integration trajectory from 1988 to 1996				
Remained in category 1	1100	17 698	6	34
Decrease	7174	115 127	30	26
Remained in category 2 or 3	6299	103 005	24	23
Increase	4707	77 038	9	12
Remained in category 4	7246	119 045	12	10

^{*} Construction of the social integration index is described in reference 19.

Table 3

Relative Hazard Ratios for Suicide During 1988–2012, by Social Integration Category Measured in 1988

Variable	Relative Hazard Ratio (95% CI)	
	Adjusted for Age	Adjusted for Age and Other Variables [*]
Social integration category [†]		
1 (Lowest)	Referent	Referent
2	0.70 (0.43–1.15)	0.76 (0.47–1.24)
3	0.47 (0.27–0.82)	0.52 (0.30–0.91)
4 (Highest)	0.35 (0.21–0.59)	0.41 (0.24–0.69)
<i>P</i> for trend	<0.001	<0.001

^{*} Baseline occupation; history of hypertension, hypercholesterolemia, diabetes, or renal failure self-reported in 1988 (yes or no for each); time-updated employment status (full-time, part-time, retired, or disabled); smoking status (never, former, or current [1 to 14, 15 to 24, or ≥25 cigarettes/d]); daily alcohol intake (none or current [0.1 to 9.9, 10 to 29.9, or ≥30 g/d]); quintile of daily caffeine intake; antidepressant medication use; body mass index (<21, 21 to 22.9, 23 to 24.9, 25 to 27.4, 27.5 to 29.9, or ≥30 kg/m²); having had a routine physical examination in the previous 2 y (yes or no); and weekly physical activity (<3, 3 to 8.9, 9 to 17.9, 18 to 26.9, or ≥27 metabolic equivalent tasks per week).

[†] Construction of the social integration index is described in reference 19.

Table 4

Relative Hazard Ratios for Suicide During 1996–2012, by Social Integration Trajectory From 1988 to 1996

Variable	Relative Hazard Ratio (95% CI)	
	Adjusted for Age	Adjusted for Age and Other Variables*
Social integration trajectory from 1988 to 1996 [†]		
Remained in category 1 (lowest)	Referent	Referent
Decrease	0.73 (0.31–1.81)	0.86 (0.35–2.10)
Remained in category 2 or 3	0.69 (0.28–1.70)	0.80 (0.32–1.99)
Increase	0.35 (0.12–0.98)	0.41 (0.14–1.16)
Remained in category 4 (highest)	0.30 (0.11–0.80)	0.36 (0.13–0.99)
<i>P</i> for trend	0.003	0.008

* Baseline occupation; history of hypertension, hypercholesterolemia, diabetes, or renal failure self-reported in 1988 (yes or no for each); time-updated employment status (full-time, part-time, retired, or disabled); smoking status (never, former, or current [1 to 14, 15 to 24, or ≥25 cigarettes/d]); daily alcohol intake (none or current [0.1 to 9.9, 10 to 29.9, or ≥30 g/d]); quintile of daily caffeine intake; antidepressant medication use; body mass index (<21, 21 to 22.9, 23 to 24.9, 25 to 27.4, 27.5 to 29.9, or ≥30 kg/m²); having had a routine physical examination in the previous 2 y (yes or no); and weekly physical activity (<3, 3 to 8.9, 9 to 17.9, 18 to 26.9, or ≥27 metabolic equivalent tasks per week).

[†] Construction of the social integration index is described in reference 19.

Table 5

Relative Hazard Ratios for Suicide During 1988–2012, by Social Integration Components Measured in 1988

Variable	Relative Hazard Ratio (95% CI)	
	Adjusted for Social Integration Components and Age	Adjusted for Social Integration Components, Age, and Other Variables*
Marital status		
Not married	Referent	Referent
Married	0.56 (0.36–0.87)	0.60 (0.38–0.94)
Relatives and friends score[†]		
1 (Lowest)	Referent	Referent
2	0.56 (0.35–0.90)	0.57 (0.35–0.92)
3	0.47 (0.25–0.88)	0.46 (0.24–0.87)
4 (Highest)	0.49 (0.27–0.92)	0.50 (0.27–0.92)
Relatives and friends frequency inde[†]		
1 (Lowest)	Referent	Referent
2	1.18 (0.72–1.95)	1.23 (0.74–2.04)
3 (Highest)	1.31 (0.71–2.40)	1.39 (0.75–2.57)
Religious service attendance		
Less than once per week	Referent	Referent
At least once per week	0.47 (0.32–0.70)	0.49 (0.33–0.73)
Social group participation		
None	Referent	Referent
Any (>0 h)	0.99 (0.70–1.40)	1.04 (0.74–1.47)

* Baseline occupation; history of hypertension, hypercholesterolemia, diabetes, or renal failure self-reported in 1988 (yes or no for each); time-updated employment status (full-time, part-time, retired, or disabled); smoking status (never, former, or current [1 to 14, 15 to 24, or ≥25 cigarettes/d]); daily alcohol intake (none or current [0.1 to 9.9, 10 to 29.9, or ≥30 g/d]); quintile of daily caffeine intake; antidepressant medication use; body mass index (<21, 21 to 22.9, 23 to 24.9, 25 to 27.4, 27.5 to 29.9, or ≥30 kg/m²); having had a routine physical examination in the previous 2 y (yes or no); and weekly physical activity (<3, 3 to 8.9, 9 to 17.9, 18 to 26.9, or ≥27 metabolic equivalent tasks per week).

[†] Constructed using data on the self-reported number and frequency of contact with close friends and relatives (19). Score increases with the number and frequency of contacts.