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THE ASSOCIATION OF SOCIAL RELATIONSHIPS AND ACTIVITIES WITH MORTALITY: PROSPECTIVE EVIDENCE FROM THE TECUMSEH COMMUNITY HEALTH STUDY

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The prospective association of social relationships and activities reported during a round of interviews and medical examinations in 1967–1969 with mortality over the succeeding nine to 12 years was examined for a cohort of 2754 adult (aged 35–69 years as of 1967–1969) men and women in the Tecumseh Community Health Study. After adjustments for age and a variety of risk factors for mortality, men reporting a higher level of social relationships and activities in 1967–1969 were significantly less likely to die during the follow-up period. Trends for women were similar, but generally nonsignificant once age and other risk factors were controlled. These results were invariant across age, occupational, and health status groups. No association was observed between mortality and satisfaction with social relationships or activities. How and why social relationships and activities predict mortality are discussed and identified as important foci for future research.

family characteristics; health surveys; interpersonal relations; marriage; mortality; social environment; social isolation

Social ties and relationships have long been believed to promote health and protect people against disease, even death (1). Married persons have consistently been found to be mentally and physically healthier and have lower rates of mortality than the unmarried, with these differences more pronounced among men than among women (1–5). A growing body of research and theory suggests that supportive social relationships more generally may promote health and protect or buffer individuals against psychosocial stressors and their deleterious impact on health (6–8).

The evidence relating social relationships and support to health and disease is, however, less than conclusive. There are

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Abbreviation: FEV_1, forced expiratory volume in one second.

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many cross-sectional or retrospective studies, few longitudinal or prospective ones; the study groups are often small or specialized (e.g., employees in a single occupation or organization), seldom a sample from a large general population; the measures of social relationships and supports studied are often quite restricted (e.g., only marital status); and the assessments of health and disease are usually limited in their scope and/or validity.

Prospective analyses of data from major epidemiologic studies of total communities can overcome many of the limitations of prior research. This paper reports such analyses of data from the Tecumseh Community Health Study, partially replicating work by Berkman and Syme (9) with data from the Human Population Laboratory Study of Alameda County, California. The analyses of the Tecumseh data also extend and improve upon the Alameda County research in several ways.

In a nine-year mortality follow-up of a representative sample of 6928 adults in Alameda County, first surveyed in 1965, Berkman and Syme (9) found that "people who lacked social and community ties were more likely to die in the follow-up period than those with more extensive contacts" (p. 186). Using four measures of social and community ties—marital status, contact with friends and relatives, church membership, and membership in "informal and formal" group associations—and a weighted composite of these (Social Network Index), these investigators consistently found more isolated individuals to have higher age-adjusted relative risks of dying. The results for the composite Social Network Index held with separate controls for self-reported health status, socioeconomic status, and health behaviors and practices at the time of the initial survey, though a portion of the overall relationship between the Social Network Index and mortality appeared to be a function of health behaviors and practices.

Berkman and Syme (9) note the lack of biomedical measures of morbidity at the time of the initial Alameda County survey. Such measures are available in the Tecumseh data, and provide an alternative, probably more valid, assessment of the extent to which the relationship between social networks and mortality reflects the dependence of both on underlying health problems. Such measures also allow us to determine the extent to which social networks affect the risk of mortality among otherwise healthy people (presumably by influencing incidence of new disease) versus affecting the survival rates of persons with known morbidity. The Alameda County Study considered only a limited range of social relationships and activity; the Tecumseh data include a wider range of such variables. Whereas Berkman and Syme largely compared persons with regard to the presence or absence of social ties, the Tecumseh Study allows an assessment of the impact of the frequency or intensity of social relationships and activities.

Finally, the findings of Berkman and Syme (9), and other findings that are based on measures of the presence or absence of social activities, are ambiguous as to the mechanisms that produce the obtained relationships. As already noted, social relationships may affect mortality either by affecting disease incidence or survival rates among those with disease. What is it about social relationships that produces such effects—the diversion they provide from the routines and hassles of daily life, the level of activity or functional capacity they require, or the content and quality of the relationships? The analyses reported here begin to address such questions because they include a somewhat wider range of social relationships and activities than the Alameda County data, along with measures of

satisfaction with these relationships and activities as well as their existence and frequency.

METHODS

Study population. The present analyses are based on a cohort of 1322 men and 1432 women who were interviewed and medically examined during the third round of the Tecumseh Community Health Study (10, 11) in 1967–1969 and who were 35–69 years old at that time. The population eligible for the third round of exams consisted of those living adults examined in one or both of the first two major rounds of data collection (in 1959–1960 and 1962–1965) plus those not previously examined who were in a 10 per cent sample of dwelling units in the study area. The 2754 persons actually interviewed and examined, and hence included in the cohort analyzed here, represented 71 per cent of the eligible population of 3873. Response rates in the first two rounds of the study ranged between 82 and 88 per cent of the study area population.

The nonrespondent portion of the eligible population for the third round comprised 11.4 per cent (or 442 persons) known to have left the area, 1.5 per cent (or 60 persons) whose whereabouts could not be determined at the time of data collection, and 15.9 per cent (or 617 persons) who were located in the study area but refused to participate or were temporarily unavailable. In 1978–1979, mortality experience was ascertained for all 3873 persons eligible for round three. The mortality experience of those who had left the area prior to the third round data collection or could not be located at that time (49 deaths among 502 persons, or 9.8 per cent) was not significantly different from the mortality experience of the cohort who were interviewed and examined and are analyzed here (259 deaths among 2754 persons, or 9.4 per cent). The mortality rate among those who refused to participate or were temporarily unavailable was significantly higher ($p < 0.001$) than both of these other groups (94 deaths among 617 persons, or 15.2 per cent). This largely reflects the fact that persons with serious illnesses were less able or willing to participate.

Data collection. Data on social integration and activities were obtained in structured personal interviews conducted in respondents' homes in 1967–1969. Data on morbidity and functional status derived from physiologic tests and a medical history and examination performed on each person in the Tecumseh Community Health Study clinic after his or her interview. Mortality status was ascertained in 1978–1979 for virtually everyone who was ever examined in the Tecumseh Study. For the cohort analyzed here, 100 per cent ascertainment was achieved (covering all persons who moved away as well as all persons still living in the study area). Death certificates were obtained for all reported deaths but one.

Measures. Mortality from all causes as of the date of ascertainment between March 1978 and June 1979 was selected as the dependent variable for the major analyses reported here. Analyses for separate causes of death are summarized briefly, but are not reported in detail because of the relatively small number of deaths from any single cause and the uncertain and variable quality of the cause of death information on death certificates. We also regard mortality from all causes as a theoretically more appropriate dependent variable, since social relationships and activities are believed to have quite general effects in promoting health and preventing diseases of all types (6, 9, 12).

Age in years and the following indicators of physical status or morbidity as of 1967–1969 were considered as potential confounding variables in the analyses: 1) a diagnosis of suspect or probable coro-

nary heart disease, defined as a probable history of myocardial infarction or angina or electrocardiographic evidence of myocardial infarction (Minnesota codes 1-1 or 1-2) (13); 2) chronic bronchitis or persistent cough or phlegm (14); 3) probable hypertension, defined as blood pressure levels equal to or greater than 160 mm systolic or 95 mm diastolic or the taking of antihypertensive medication; 4) systolic and diastolic fifth phase blood pressures; 5) serum cholesterol (15); 6) blood glucose, determined by an autoanalyzer using the modified Hoffman method; 7) FEV_1 score, forced expiratory volume at one second adjusted for sex, age, and height using the FEV_1 values of nonsmoking respondents without respiratory disease or symptoms; and 8) the Quetelet ratio, weight/height^2. Other variables included as possible confounding factors are cigarette smoking, alcohol drinking, education, employment status, and occupation.

The measures of social relationships and activities fall into four major categories: 1) intimate social relationships (marital status, visits with friends and relatives, going on pleasure drives and picnics); 2) formal organizational involvements outside of work (going to church or meetings of voluntary associations); 3) active and relatively social leisure (going to classes or lectures, movies, plays, fairs, museums, etc.); and 4) passive and relatively solitary leisure (watching television, listening to the radio, reading). The measures other than marital status derive from the following self-administered questions:

1) On the average, how often have you done each of these things during the past 12 months: (a) visiting with friends, neighbors; (b) visiting with relatives; (c) going to the movies; (d) going to watch sports events; (e) going to concerts, plays, etc.; (f) going to fairs, museums, exhibits, etc.; (g) attending meetings; (h) going to church; (i) going on pleasure drives, picnics, etc.; and (j) going to classes or lectures?

2) About how many hours in an average day or an average week do you spend: (a) watching television (total time); (b) listening to the radio (total time); (c) listening to the news on radio or watching news on television; (d) reading newspapers; and (e) reading magazines or books?

All measures of social relationships and activities except dichotomous marital status ranged from a low level of activity or interaction (coded 1, meaning "did not do this at all in the past year" or " less than 15 minutes a day" in the case of passive leisure) to a high level (coded 6, meaning "did this more than once a week," or coded 8, meaning "more than five hours a day" in the case of passive leisure). Three of the measures—frequency of visiting friends and relatives (items 1a and 1b above), frequency of attending spectator events (items 1c, 1d, 1e, and 1f above), and time spent listening to the radio or reading (items 2b, 2c, 2d, and 2e above) are multi-item indices derived by taking the average of the responses to the separate items. Parallel questions asked "how much satisfaction do you get from each of these things" (i.e., the activities listed above). Responses were coded from 1 ("none") to 5 ("a great deal") and parallel satisfaction indices were formed by averaging appropriate items (cf. discussion of results below).

Statistical analysis. The associations of social relationships and activities with mortality were examined via contingency tables, ordinary least squares correlation and regression, and multiple logistic function analysis using maximum likelihood estimation procedures (16–18). The various methods of analyses yielded very similar substantive conclusions. This report relies on the contingency table and multiple logistic function analyses for estimating the size, nature, and statistical significance of the effects of social relationships and activities on mortality, since these methods are more appropriate

than ordinary least squares correlation and regression for analyses involving a dichotomous dependent variable such as mortality.

Multiple logistic coefficients for the effect of each social relationship and activity on mortality were estimated under three conditions: 1) with no controls for potential confounding variables (i.e., zero-order coefficients); 2) with age, treated as a continuous variable, controlled (i.e., included in the multiple logistic equation); and 3) with age and the measured, significant biomedical and behavioral risk factors for mortality controlled. Since the results under conditions 2 and 3 are quite similar, discussion of results will focus on the age-adjusted analyses.

Statistical significance tests are based on t ratios for the logistic function coefficients. The expectation based on prior theory and research (1–9, 12) was that levels of social relationships and activities would be inversely related to mortality. Hence, one-tailed tests of significance are applied. Approximate relative risk ratios are derived from the age-adjusted logistic function analyses by computing expected mortality rates for persons 48 years old (the mean age of both males and females in this cohort) at the highest and lowest observed levels of the social relationship variable (see figure 1 for actual levels used in each case). Results of contingency table analyses, age-adjusted via direct standardization (19, 20), are also presented.

Results

Mortality and its predictors

A total of 172 (13.0 per cent) men and 87 (6.1 per cent) women died during the nine- to 12-year follow-up period. Prior to analyses of the prospective association between social relationships and mortality, multiple regression and multiple logistic function analyses were conducted to determine which of the potential confounding variables were significant independent predictors of mortality. That is, we began with the strongest predictor, age, and continued to add predictors until none of the remaining predictors could significantly ($p < 0.05$) increase the prediction of mortality in the multiple logistic analyses. For several variables—cholesterol, alcohol drinking, and weight/height^2—we tested for nonlinear as well as linear effects. No such effects were evident, except for a somewhat anomalous curvilinear relationship of cholesterol to mortality among women *only*. Women with both high and low cholesterol levels were more likely to die than those with moderate levels. This was not, however, due, as is usually hypothesized, to cholesterol having opposite linear relationships with different causes of death such as cancer and heart disease. The same curvilinear pattern appeared for all major causes of death. Since this effect was small and isolated, not substantively interpretable, and its inclusion had no consequential effects on the analyses, it is not reported in the following results.

In addition to age, two variables, FEV_1 score and coronary heart disease, were significant predictors of mortality for both sexes. Among women, probable hypertension and chronic bronchitis also significantly enhanced the prediction of mortality. Among men, cigarette smoking and being retired or disabled in 1967–1969 were also significantly positively associated with mortality, while working as a farmer or laborer was negatively associated with mortality. The two occupational variables appear to be indicators of physical vigor and activity level. The other biomedical and health behavior variables (e.g., serum cholesterol, blood glucose, obesity, and alcohol drinking) considered as potential confounding factors are not included in any analyses reported here because they had no statistically significant effect on mortality *over*

and above the variables already noted. These results reflect the mortality experience over a nine- to 12-year period of this particular cohort, and may not necessarily be generalizeable to other cohorts in the Tecumseh population studied for mortality over shorter or longer periods.

Social relationships/activities and mortality

Table 1 summarizes the results of a series of sex-specific logistic function analyses in which *each* social relationship/activity was used separately to predict mortality, with and without controls for age and other significant risk factors of mortality. The size and statistical significance of most coefficients for the social relationship and activity variables shrink markedly from the zero-order analyses to the age-adjusted analyses. However, adjustments for other mortality risk factors change the estimates of the social relationship/activity coefficients only slightly, reducing them in most, though not all, cases. These results reflect the fact that age has significant associations with both mortality and social relationships/activities, and with risk factors as well. Net of the effects of age, levels of social relationships and activities are only weakly associated with most risk factors of mortality (cf. table 2). Hence, our discussion of results will focus on the age-adjusted coefficients shown in table 1.

The *results for men* are generally quite consistent with our expectations based on prior theory and research. Passive/solitary leisure activities (watching television, listening to radio, reading) were *positively* associated with mortality (table 1). However, the more involved men were in all of the other (i.e., more active) social relationships and activities, the less likely they were to die over the nine- to 12-year follow-up period. Five of these seven relationships are statistically significant ($p < 0.025$) adjusted for age, with four remaining significant ($p < 0.05$) after adjustment for all risk factors. The estimated age-adjusted relative risks for those scoring the lowest compared to those scoring the highest (estimated from the logistic coefficients as indicated above) on these five variables range from 1.93 (nonmarried vs. married) to 2.80 (meetings of voluntary associations). These results are generally quite similar to those Berkman and Syme (9) obtained with somewhat different measures, though varying slightly from theirs in the size and significance of the effects. Notable, perhaps, are the somewhat weaker associations of mortality with friend and relative contact and religious involvement, and the much stronger association of mortality with other organizational involvements in Tecumseh compared to Alameda County. The predictive power of leisure activities which involve getting out with other people, either friends and family (e.g., pleasure drives and picnics) or others (e.g., cultural and sports events, classes, and lectures) were not assessed in Alameda County, but prove consequential in Tecumseh (estimated age-adjusted relative risks of 2.00–2.27).

The *results for women* in table 1 are less strong and consistent, relative to both the Tecumseh Study male data and the Alameda County results (9) for women as well as men. Passive leisure activities (watching television, listening to radio, reading) (table 1) are even more *positively* related to mortality among women than among men. Although all other social relationships and activities but one (frequency of attending meetings) are negatively related to mortality among the Tecumseh women (table 1), only the church attendance coefficient is statistically significant ($p < 0.05$) net of age and other risk factors. The finding that marital status is less significant for women compared to men is consistent with the results of Berkman and Syme (9) and others (1–3). However, the relative lack of association with mortality of other so-

TABLE 1

Multiple logistic coefficients for association of social relationships and activities with mortality, Tecumseh Community Health Study, 1967–1979†

Social relationships and activities	Zero-order		Adjusted for age		Adjusted for age and other risk factors	
	Male	Female	Male	Female	Male	Female
Intimate social relationships						
Marital status	−0.862***	−0.879***	−0.710***	−0.307	−0.614*	−0.262
Frequency visiting friends and relatives	−0.092	0.010	−0.088	−0.026	−0.078	−0.002
Frequency going on pleasure drives/picnics	−0.128**	−0.172**	−0.127**	−0.118	−0.099	−0.102
Organizational involvements						
Frequency of church attendance	−0.071	−0.121*	−0.046	−0.134**	−0.018	−0.134**
Frequency attending meetings of voluntary associations	−0.392***	−0.010	−0.280***	0.026	−0.222**	0.070
Active/social leisure activity						
Frequency attending spectator events (movies, plays, fairs, sports events)	−0.932***	−0.749***	−0.443***	−0.274	−0.419**	−0.155
Frequency attending class or lectures	−0.353***	−0.152	−0.252**	−0.096	−0.260*	−0.060
Passive/solitary leisure activity						
Time spent watching television	0.137**	0.251***	0.110*	0.195***	0.024	0.190***
Time spent listening to radio or reading	0.361***	0.167	0.224*	0.147	0.083	0.130

*** $p < 0.005$; ** $p < 0.025$; * $p < 0.05$ (one-tailed tests).

† After deletion of missing data, numbers range from 1279 to 1322 for men, and from 1364 to 1431 for women. Risk factors controlled were: coronary heart disease, FEV_1, smoking, and working as a farmer or laborer, or being retired or disabled for men; coronary heart disease, FEV_1, hypertension, and bronchitis for women.

cial relationships and activities, especially visits with friends and relatives, is quite in contrast to the generally stronger predictive power such variables had among women in Alameda County. In the Tecumseh data, the age-adjusted estimated relative risk for less socially involved and integrated women compared to the more active and integrated ranges from 1.07 in the case of marital status to 1.86 for church attendance (and is, of course, less than 1.00 for frequency of attending meetings). The comparable relative risks in Alameda County were often in the range of 2.0–3.0. Possible reasons for these differences are discussed below.

Figure 1 presents the actual age-adjusted mortality rates across levels of social relationships and activities (directly standardized to the sex-specific, overall age distribution of this Tecumseh Study cohort, using three categories of age: 35–44, 45–54, and 55–69 years). These data are generally consistent with the results of the logistic analyses which assume that age and social relationships/activities are continuous variables, linearly related to mortality. Figure 1 suggests, however, that the relationship of social relationships and activities to mortality may not be perfectly linear, nor even always monotonic.

The results *for women* are generally weak enough to make the issue of nonmonotonicity moot. Wherever the results *for men* indicate a clear association of social relationships and activities with mortality, the lowest level of each social relationship or activity always has the highest mortality rate; but mortality rates do not decline monotonically as the level of social integration or activity increases. The lowest level of mortality often occurs at a moderate level of social integration or activity, and in some cases (i.e., attending church or classes and lectures), mortality actually increases as the level of activity begins to exceed the moderate level. However, only the relationship with going to classes and lectures proved significantly curvilinear in tests introducing quadratic terms into multiple logistic analyses.

Cumulated relationships and activities

Thus far, each type of social relationship or activity has been considered separately. The consistent direction of the results (cf. table 1) suggests that the cumulative effects of a number of social relationships and activities on mortality should be greater than their separate effects. This expectation is reinforced by the data of table 2 which show that the correlations among the social relationship/activity variables are low to moderate for both men and women.

The issue of cumulative effects was examined both by allowing multiple activities and relationships to be included in the independent variable set in multiple logistic analyses and by creating summative indices of "social integration." The results of these analyses indicate that the predictive power of social relationships and activities for mortality is somewhat cumulative, with the absence of all or most such social ties posing the greatest risk. Among men, both going to meetings and marital status make significant ($p < 0.05$) independent contributions to predicting mortality net of each other and all confounding variables. This suggests that both formal and informal relationships are important and not totally substitutable. Among women, of course, only church attendance is significantly related to mortality.

Because of the tendencies to nonmonotonicity observed in figure 1, two different cumulative indices of social relationships and activities were created using the first seven variables (active, social relationships) listed in table 1. The first, a "count" index, simply counts the number of variables on which a person scores above the lowest level. For example, if the respondent was married and

was not involved in any of the six other relationships or activities in the past year, her count index would be one. The second, a "mean" index, averages the actual responses to these seven variables (coding marital status as 1 for not married, 6 for married). Table 3 shows the logistic regressions of mortality on these indices with controls for age and for age and all other significant risk factors. *Among men,* these cumulative indices are significantly related to mortality when age is a covariate and when all confounding variables are covariates. *Among women,* the relationships of both indices to mortality are significant ($p < 0.05$) net of age, but become nonsignificant when all risk factors are covariates.

Figure 2 graphically presents the age-adjusted mortality rates across levels of each of these indices. The relative risks of the lowest compared to the highest levels of social activities and relationships range from about 2.0 to almost 4.0. The somewhat greater degree of association of the count index with mortality reflects the tendencies evident in figure 1 for mortality to be especially high at very low levels of social relationships or activities and to sometimes increase at very high levels.

Overall, the data in table 3 and figure 2 reinforce other evidence (1–5, 9) of the prospective association of social relationships and activities with mortality. They also suggest, in line with other studies (8, 9), that various types of relationships and activities are partially, though not fully, substitutable for each other, and that it is the lack of any meaningful social relationships or ties which is most deleterious for health.

Interaction analyses

Tests were made via multiple logistic analysis to determine whether the relationships embodied in tables 1–3 and figures 1 and 2 hold uniformly for the entire Tecumseh Study cohort, or whether the association of social relationships and activities with mortality was greater for some subgroups in the population. Specifically, tests were made for whether these relationships differ significantly across: (a) occupational groups (professional and managerial vs. clerical and sales vs. skilled craftsmen and foremen vs. semi-skilled and unskilled vs. housewives); (b) age groups (35–44, 45–54, 55–69 years); and (c) groups differing in health status (with coronary heart disease (CHD) vs. with major risk factors of CHD vs. no evidence of CHD and little or no CHD risk). In no case was there more than chance level evidence of significant differences, though there was a slight tendency toward a larger association of social relationships and activities with mortality among persons with coronary heart disease than among persons with elevated risk factors only or with little or no risk of coronary heart disease. All in all, however, these analyses suggest that social relationships and activities are equally predictive of mortality across a wide range of age, occupational, and health status groups.

Satisfaction with relationships and activities

Finally, mortality was analyzed in relation to the degree of satisfaction with the major relationships and activities in table 1, and to interactions between satisfaction and the intensity or frequency of the activity or relationship. Since parallel satisfaction measures were unavailable for the "active leisure" variables, measures of satisfaction with watching and playing sports were used as the closest available approximation. With the exception of one anomalous result for women, there was no evidence that satisfaction with relationships and activities, considered either alone or in interaction with the intensity or frequency of activity, had any significant association with mortality once the intensity or frequency of an ac-

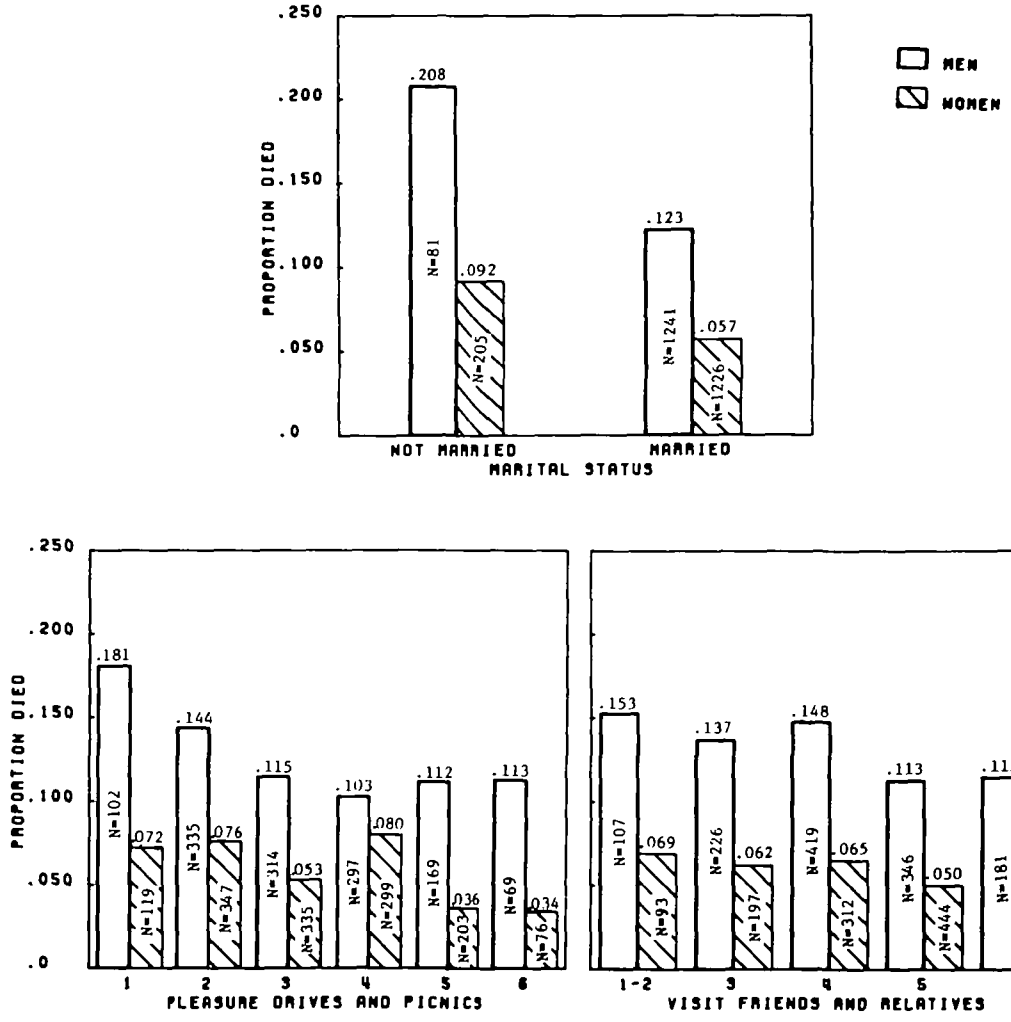

FIGURE 1. Age-adjusted mortality rates of men and women by level of social relationships and activities (Tecumseh Community Health Study, 1967–1979). The levels of each variable (except marital status) are as follows: 1) not at all this past 12 months; 2) one to five times this past 12 months; 3) once a month or every two months; 4) once every two or three weeks; 5) once a week; and 6)more than once a week.

tivity or relationship was controlled. The anomalous finding among women was that satisfaction with attending meetings was markedly *positively* related to mortality. There was a somewhat consistent tendency for other satisfaction measures to show small positive associations with mortality among women.

Social relationships, illness, and mortality

That the predictive negative associations of most social relationships and activities with mortality persist, most clearly among men, even with rather stringent controls for age and prior health status strongly suggests that this association is *not* spuriously produced by the fact that people who are ill are both more likely to die and less likely to engage in social relationships and activities. The indicators of prior health status included in these analyses span a range of medical problems and also include age, and in the case of men, two occupational variables (working as a farmer or laborer or not,

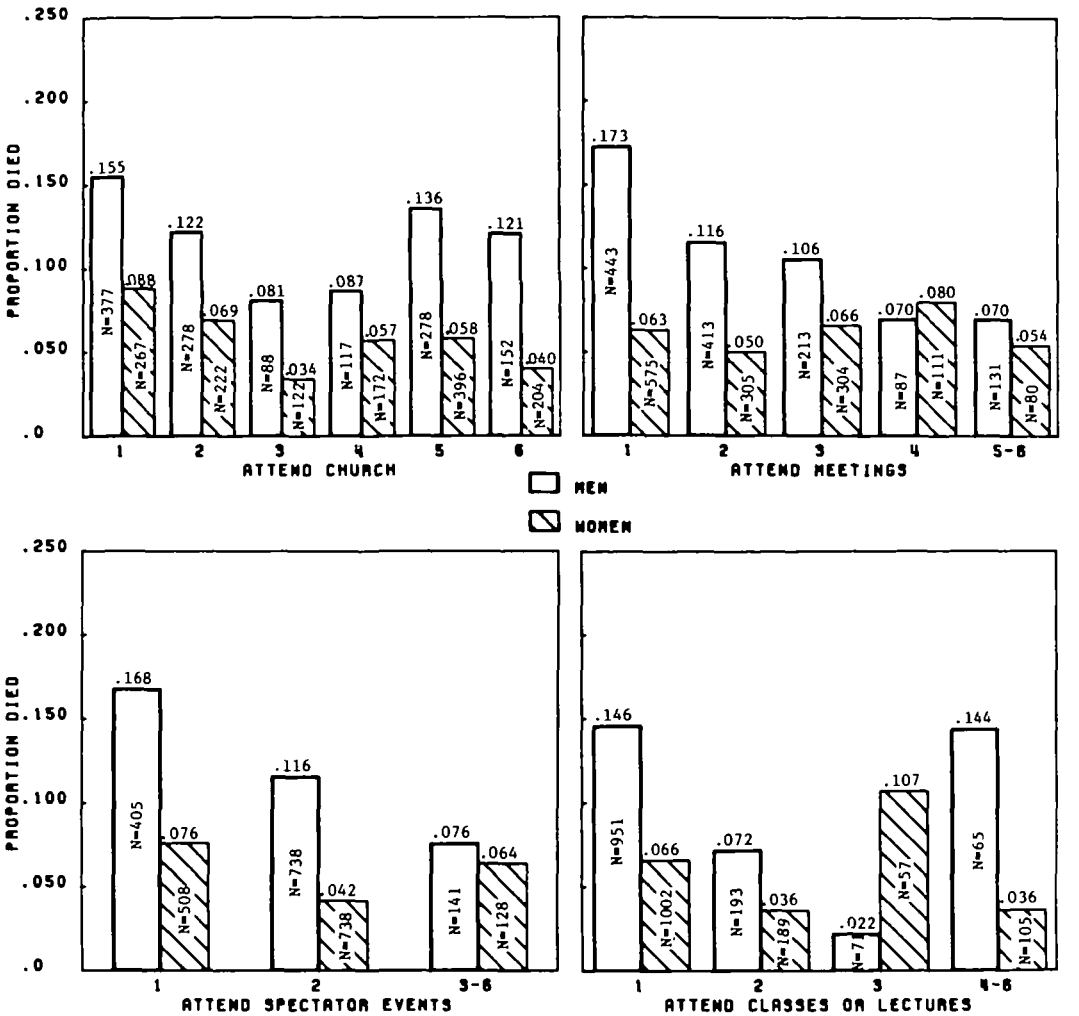

FIGURE 1—*Continued*

and being retired or disabled or not) which index functional status and capacity. In contrast, these same controls do seem to account for much or all of the association between passive solitary activities and mortality, again especially in the case of males. These passive activities appear to be, as we initially suspected, a function of health status, rather than a predictor of it. The same *cannot,* however, be said regarding the more active and social relationships and activities.

We have taken two additional steps to increase our own confidence that the negative associations of the more active social relationships and activities with mortality are not a spurious product of preexisting illness. First, following the lead of Berkman and Syme (9), we reasoned that if these negative associations were a spurious product of activity-limiting illnesses present in 1967–1969 that culminated more or less directly in death, then social relationships and activities should be more strongly related to death in the years immediately after the 1967–1969 interviews and exams, and more weakly related to deaths in later years. We found no evidence of this, however, in further analyses predicting male

TABLE 2

*Intercorrelations (Pearson r > 0.05) among social relationship/activity variables, biomedical risk factors, and mortality (males above diagonal, females below), Tecumseh Community Health Study (1967–1979)**

Variable†	1	2	3	4	5	6	7	8
Intimate social relationships								
1. Marital status				0.091	0.056			
2. Visit friends/relatives			0.350	0.078	0.106	0.146		
3. Going on drives/picnics	0.078	0.308		0.096	0.079	0.243	0.057	
Organizational involvements								
4. Church attendance		0.067	0.086		0.208	0.136	0.212	−0.123
5. Meeting attendance		0.103	0.117	0.197		0.353	0.347	−0.071
Active/social leisure activity								
6. Spectator events	0.073	0.111	0.196	0.116	0.308		0.235	
7. Classes/lectures				0.170	0.298	0.256		−0.135
Passive/solitary leisure activity								
8. Watch television				−0.176	−0.121	−0.142	−0.177	
9. Listen to radio/read		0.117						0.213
Risk factors: both sexes								
10. Age	−0.288		−0.060		−0.065	−0.285	−0.056	0.131
11. Coronary heart disease						−0.061	−0.052	
12. FEV_1					0.074	0.074		−0.072
13. Mortality	−0.095		−0.054	−0.052		−0.081		0.109
Sex-specific risk factors								
14. ‡						−0.136		0.097
15. §				−0.100				
16. ¶								

TABLE 2—*Continued*

Variable†	9	10	11	12	13	14	15	16
Intimate social relationships								
1. Marital status	−0.077	−0.069			−0.090			
2. Visit friends/relatives						0.067	−0.058	
3. Going on drives/picnics					−0.056			
Organizational involvements								
4. Church attendance		−0.066	−0.057	0.125				−0.161
5. Meeting attendance		−0.146	−0.087	0.097	−0.140	−0.092		−0.070
Active/social leisure activity								
6. Spectator events		−0.250	−0.086	0.073	−0.140	−0.090	−0.083	
7. Classes/lectures	0.073	−0.115	−0.053	0.062	−0.082	−0.074		−0.064
Passive/solitary leisure activity								
8. Watch television	0.170		0.087	−0.074	0.062	0.178	−0.078	0.099
9. Listen to radio/read		0.110	0.080		0.085	0.107		0.066
Risk factors: both sexes								
10. Age			0.277	−0.124	0.346	0.402	0.103	−0.112
11. Coronary heart disease		0.190		−0.095	0.285	0.192		
12. FEV_1			−0.075		−0.173	−0.065		−0.247
13. Mortality		0.192	0.189	−0.141		0.279		0.057
Sex-specific risk factors								
14. ‡		0.364	0.182	0.056	0.144		−0.054	
15. §				−0.177	0.086			
16. ¶								

* Only significant ($p < 0.05$, two-tailed) correlations are shown.

† Variables 1, 13, 14, 15, and 16 are dichotomies. All variables except mortality were assessed in 1967–1969.

‡ Variable 14 = hypertension for women; retired or disabled for men.

§ Variable 15 = chronic bronchitis for women; occupation of farmer or laborer for men.

¶ Variable 16 = current smoker for men; there is no variable 16 for women.

TABLE 3

Multiple logistic analyses of effects of two indices of social relationships and activities on mortality, net of confounding variables, Tecumseh Community Health Study, 1967–1979

Variables	Males				Females			
	Count index†		Mean index†		Count index†		Mean index†	
Constant	−6.101	−5.285	−6.132	−5.278	−6.281	−5.964	−5.716	−5.328
Age	0.105***	0.092***	0.112***	0.096***	0.083***	0.078***	0.078***	0.071***
Social relationships and activity index	−0.251***	−0.210***	−0.522***	−0.410**	−0.146*	−0.083	−0.325*	−0.221
Risk factors: both sexes								
Coronary heart disease		1.556***		1.118***		0.998***		0.986***
FEV_1		−0.295***		0.243**		−0.548***		−0.499***
Male risk factors								
Retired or disabled		0.695**		0.794**				
Farmer or laborer		−1.629**		−1.572**				
Smoker		0.556***		0.565***				
Female risk factors								
Bronchitis						0.745**		0.746**
Hypertension						0.418		0.432

*** $p < 0.005$; ** $p < 0.025$; * $p < 0.05$ (one-tailed tests).

† Mean index is mean over full range of values of responses to first seven variables in table 1. Count index tallies for the same items the number of responses above the lowest level responses shown in figure 1. Column 1 of each pair of columns shows the equation predicting mortality from age and the indicated index of social relationships/activities; column 2 shows a similar equation including all relevant risk factors for mortality.

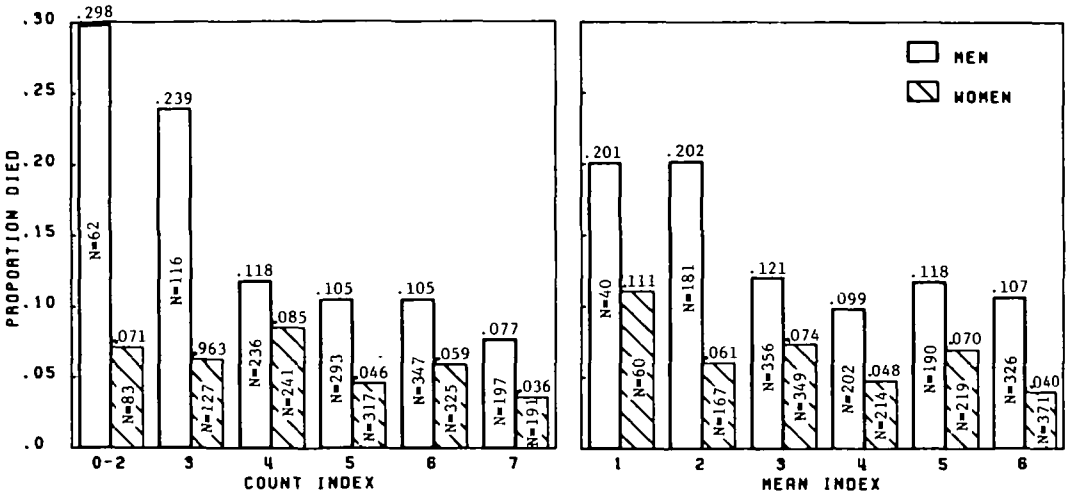

FIGURE 2. Age-adjusted mortality rates of men and women across levels of summary indices of social relationships and activities (Tecumseh Community Health Study, 1967–1979). The count index value is the sum of the number of responses greater than the lowest level for each of the seven variables in figure 1. The mean index is the mean over the full range of values for these seven variables. For these purposes, married has a value of 6, unmarried, 1. The six levels shown represent a categorization of actual mean values as follows: 1 = mean $\leq$ 2.00; 2 = 2.00–2.49; 3 = 2.50–2.99; 4 = 3.00–3.24; 5 = 3.25–3.49; 6 $\geq$ 3.50.

deaths during different intervals of the follow-up period. If anything, the association of social relationships and activities indices with mortality is weakest in the two to four years immediately after the initial interviews and exams, and reaches its peak in strength during the middle five to eight years of the follow-up period.

Second, drawing on the medical histories taken in all three rounds of examinations in the Tecumseh Community Health Study, we constructed a dichotomous variable indicating whether a person acknowledged ever or currently having one or more of the following serious diseases: hypertension, heart disease, stroke, diabetes, emphysema, tumor, kidney disease, or major surgery such as cholecystectomy, gastrectomy, mastectomy, and others. Among men, 55 per cent of whom acknowledged currently or ever having one or more of these diseases, this measure proved to be a significant ($p < 0.05$) predictor of mortality over and above all of the risk factors shown in table 3, though a less strong predictor than these other risk factors. Among women, 71 per cent of whom acknowledged one or more diseases, this variable was positively, but not significantly, associated with mortality, again net of all other risk factors shown in table 3. Adding this acknowledgement of disease variable to the full multiple logistic equations shown in table 3 or to the equations involving all risk factors for major variables in table 1 (i.e., marital status and going to meetings for men, marital status and church attendance for women) hardly alters the size or significance of the coefficients for the social relationships and activities variables. Once again, we could find no evidence that the predictive association of social relationships and activities with mortality can be considered solely, or even primarily, a spurious product of prior health status.

Analyses by cause of death

As indicated under "Methods," we have not focused on individual causes of death for both methodological and substantive reasons. We have, however, done exploratory analyses for the two major causes:

1) death due to malignant neoplasms (i.e., *International Classification of Diseases* (ICD) codes 144-226.8) as primary or underlying cause, and 2) death due to ischemic heart disease (i.e., ICD codes 410-412.4) as primary or underlying cause. Among males, 5.1 per cent died of ischemic heart disease and 3.3 per cent of malignant neoplasms during the follow-up period. Among females, 1.7 per cent died of heart disease and 1.7 per cent of neoplasms. Thus, these dependent variables are highly skewed. Among both men and women, social relationships and activities generally manifested negative associations with mortality from both of these causes, and one or more of the social relationships/activity measures were significant even after controls for significant risk factors included in this study. The most interesting finding in these analyses was that social relationships and activities had generally strong and significant predictive associations with heart disease mortality among women—results similar to the findings for overall mortality among men, and the clearest evidence among women that social relationships and activities are important predictors of mortality. Among men, the effects of social relationships and activities on mortality were less strong and significant for each specific cause than they were for mortality from all causes. We regard results of these cause of death analyses, however, as preliminary and suggestive at best.

Discussion

This analysis of the Tecumseh Community Health Study data replicates and extends previous findings, most notably those of Berkman and Syme (9), that social relationships and activities are associated prospectively with mortality. The Tecumseh data included a wider range of assessments of health and functional status at the beginning of the study period than were available in the Alameda County data analyzed by Berkman and Syme. The associations of the social variables with mortality persist even with controls for age and a wide range of indicators of health and disease status. Thus, social relationships and activities appear to constitute an additional set of consequential risk factors for mortality. The risk associated with these social variables is invariant across a wide range of age, occupational, and health status groups.

Satisfaction with relationships/activities was expected to be significantly inversely related to mortality, either net of, or in interaction with, the intensity or frequency of these relationships (i.e., satisfaction would be more consequential for mortality among people who frequently engaged in an activity or relationship). The quality of relationships as well as their quantity should be important in influencing health outcomes. The lack of significant results here may be due to several factors. First, reports of satisfaction with relationships and activities may be much less stable over time than reports of the intensity or frequency of the same relationships and activities. Thus, the satisfaction measures may be too unreliable to produce significant effects on mortality. Second, satisfaction may not be among those aspects of relationships and activities which affect mortality. If, for example, the supportiveness of a relationship or activity is what is important in relation to mortality, this may not be captured at all by measures of satisfaction since people may be satisfied with a relationship or activity for many different reasons. Finally, it may be that the maintenance of some minimal level of relationship or activity is somehow more critical than the quality of those relationships.

Several ways in which the results of the Tecumseh Study differ from or extend prior evidence, most notably that of Berkman and Syme (9), deserve mention. The associations of social relationships and activities are generally significant

and sizable only among males in Tecumseh, though they are similar but weaker among women. It should be emphasized that only two measures of social relationships and activities (i.e., going to meetings and church attendance) showed significantly ($p < 0.05$) different associations with mortality for males versus females. Nevertheless, the tendency for the relationships to be stronger among males is remarkably consistent. The Tecumseh data are also notable for the significance of formally organized relationships and activities (i.e., meeting attendance, going to classes, lectures, or spectator events), and the lack of significance of "visiting" friends, relatives, and neighbors.

We cannot be certain of the reasons for these departures from prior findings, but suspect they reflect the differing processes of social integration and activity which characterize a small city in a rural area such as Tecumseh vis-à-vis a metropolitan area such as Alameda County, California. It is possible that meaningful social relationships and activities are more likely to occur as part of the normal fabric of daily life in places like Tecumseh. Thus, for example, friends and relatives may be seen and "visited with" more often at work or while shopping and performing other routines of daily life. (The term "visit" in Tecumseh is used to mean merely talking with another person, as well as physically going to see him.) This may be especially true for women. The result is that these specific measures may be less differentiating among persons in a small city than among residents of a metropolitan area where such interactions are more frequently special events. Generally, the measures in the Tecumseh data may more accurately index the actual level of social integration and activity of men than women, since men more often have to make special efforts to foster social relationships through formal organizations and activities. These ideas, however, remain hypotheses worthy of examination in future research across different community settings.

The present data do not fully answer the critical question of how and why social relationships and activities are predictive of mortality. Berkman and Syme (9) note the possibility that people with fewer relationships and activities are already ill at the beginning of the study period, though in ways not tapped by their measures of health status. They conclude that this explanation is relatively implausible in the Alameda County data. We feel it is even less plausible in the Tecumseh data, where we have instituted numerous controls for prior health status and functional capacity.

The data also indicate that neither the mere diversion that these activities and relationships provide nor the "satisfaction" people report with them can account for their effects. The fact that less active and more solitary activities such as reading, listening to radio, and watching television are associated with some increase, rather than a decrease, in mortality suggests that mere diversion from the work and routines of daily living is not what is effective in reducing the risk of dying. To have such beneficial effects, it appears that an activity or relationship must involve greater active effort by the individual and some contact with other people. The level of satisfaction people report with relationships and activities is also clearly not the mechanism that mediates their effects on mortality in these data, though this negative finding is amenable to several interpretations, as noted above.

Although the Tecumseh data are helpful in ruling out some possible explanations of these effects, they do not yield more positive evidence of the reasons for these effects. Social relationships and activities have been considered beneficial to human health and well-being because they give people a sense of belonging and support (1, 6–8, 12), because they give

people reasons for living that transcend their individual selves (1), and because they may in various ways influence people to engage in more preventive and therapeutic health behaviors (1, 9). There also remains the possibility that engagement in these relationships and activities is both cause and consequence of a more general psychologic sense of "coherence" and will to live (12). Future research must be addressed to clarifying these issues.

Similarly, we need further research to understand the psychophysiologic mechanisms through which social relationships and activities come to influence physical, as well as psychologic, health and well-being. A variety of analyses suggest that these relationships and activities are associated with a highly generalized resistance to disease-producing agents and processes (6, 9, 12). More careful prospective analyses of the impact of such relationships and activities on morbidity and physiologic processes are needed to confirm such arguments.

In sum, our understanding of the mechanisms through which social relationships and activities affect mortality is incomplete, as is our understanding of the mechanisms through which many other well established risk factors of mortality, such as age and smoking, operate. Similarly, our conceptualization and measurement of the nature of these activities and relationships have been crude. Yet, the robust effects of these psychosocial variables on mortality argue for further efforts to clarify our understanding of them and their impact on health.

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