CLOSE RELATIONSHIPS IN THE EPIDEMIOLOGY OF CARDIOVASCULAR DISEASE

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But I don’t think time is gonna heal this broken heart.
No, I don’t see how it can if it’s broken all apart.
A million miracles could never stop the pain.

From Anne Murray, 'Broken Hearted Me', written by Randy Goodrum

The association between close interpersonal relationships and the heart is widely cited in folklore, literature, and everyday conversation. In The Broken Heart: The Medical Consequences of Loneliness, Lynch (1977), a cardiologist, concluded that the incidence of premature death from heart disease was greater among people who lived alone or were never married. What possible mechanisms could account for the fact that single, widowed, and divorced individuals...
are 2-4 times more likely to die prematurely from cardiovascular and cerebrovascular disease?

Despite the implied connection between interpersonal relationships and the heart, there has been relatively little scientific investigation on this topic. In this chapter, we consider the role of interpersonal relationships in the epidemiology of heart disease. We review a variety of studies including those that linked social factors to mortality from diseases of the heart, those that evaluated the relationship between social support and survival for patients who have already had a heart attack, and those with different rival explanations for the relationship between social support and health outcome. We begin by introducing terms commonly used in heart disease literature. Then, we present the epidemiologic evidence. In order to place the findings in perspective, methodological issues are considered. Finally, rival explanations for the findings are evaluated.

Commonly Used Terms

Heart disease remains the major cause of death and disability in the western world. Although the rates are declining in some areas, it is estimated that 1.25 million Americans suffer a heart attack each year. In order to understand the literature on the epidemiology of coronary heart disease, it is important to consider several terms that describe outcomes. Epidemiologists commonly distinguish between 'hard' outcomes such as mortality and 'soft' outcomes such as signs and symptoms of heart disease. One important symptom is Angina Pectoris, a condition in which the muscle of the heart does not receive sufficient blood supply. This results in chest, left arm, and shoulder pain. Arteriosclerosis, commonly known as 'hardening of the arteries,' is a condition in which the arteries thicken and lose their elasticity. Atherosclerosis is a special form of Arteriosclerosis in which the blood flow to the heart is impaired because the arteries have become narrowed and lined with a fatty substance. The terms Ischemic Heart Disease and Coronary Heart Disease are often used interchangeably and refer to the condition in which the arteries are narrowed and there is insufficient blood supply to the heart. Myocardial Infarction (MI) describes the damage to the heart and death of heart muscle (also called Myocardium) that results from the reduction of blood flow to the heart. Cardiac Arrest occurs when the heart stops beating as a result of Myocardial Infarction or other reasons. Congestive Heart Failure describes the inability to pump all of the blood out of the heart and may result in blood backing up in the veins or the accumulation of fluids in other parts of the body.

The many types of heart disease may require different coping skills. MIs and cardiac arrests have abrupt onsets and typically require hospitalization. Patients who have ongoing heart disease may require Coronary Artery Bypass surgery, a procedure that requires the revascularization of the coronary arteries, or Coronary Angioplasty, which involves the dilation of the coronary arteries.
Heart procedures are stressful and usually scheduled several weeks in advance. Coronary Artery By-Pass surgery often requires a long period of adaptation. Other patients have serious heart disease which is manifest through symptomatic Angina Pectoris and may require hospitalization if it becomes frequent, severe, or unstable.

Although patients are commonly hospitalized for heart disease, a critical period occurs after hospital discharge. A coronary event may create considerable fear and anxiety. When released to home, families may not be fully equipped to cope with the uncertainties and stresses of these conditions. It has been suggested that supportive environments will enhance outcomes following a cardiac event (Davidson & Shumaker, 1987). At least three different mechanisms have been proposed to account for these outcomes. First, significant others in the support environment may encourage adherence to the medical regimen and the adoption of appropriate health behaviors. A second mechanism is modeling, whereby members of the support environment may model appropriate coping skills and health behaviors (Pearlin & Aneshensel, 1986). If a network member makes these changes at the same time, outcomes may be enhanced through mutual encouragement, mutual modeling and a reduction in the perceived difficulty of making changes. A third mechanism accounting for the benefit of social support is the stress buffering channel. Adaption may be facilitated by having network members absorb some of the stress. Further discussion of these theories and the evidence for these associations will be given later in this chapter. First, however, it will be valuable to discuss the epidemiology of heart disease.

**THE EPIDEMIOLOGY OF HEART DISEASE**

Epidemiology is the study of the determinants and distribution of disease. Although there are many different epidemiologic methods, the most respected is the prospective longitudinal cohort study. A variety of epidemiologic studies have considered both behavioral and biologic predispositions toward coronary heart disease. For example, the Framingham Heart Study began with 5,127 participants who had no visible signs of heart disease. Each participant was given a physical examination and a detailed interview, including lifestyle and demographic characteristics, then followed every other year.

Epidemiologists typically evaluate risk factors in terms of ratios. For example, suppose that 30 per cent of smokers and 24 per cent of nonsmokers died from a fatal heart attack in a population-based study. Then:

\[ \frac{.30}{.24} = 1.25 \]

Thus, smoking increased the risk of a fatal heart attack 25 per cent over that due to all other risk factors combined. The relative risk, in this example, is a measure of the etiologic importance of smoking as a cause for a fatal myocardial
infarction. A confidence interval is created around the observed risk ratio. If the interval does not include 0, then the ratio is statistically significant. Although relative risk ratios for the common coronary heart disease risk factors are frequently reported, the risk ratios for mortality associated with close interpersonal relationships are not well established. In prospective studies, the significant physiological risk factors include elevated blood lipids (NIH, 1985), blood pressure (Kannel, 1987), and blood glucose (Kannel & McGee, 1979). Behavioral variables that predispose to heart disease include cigarette smoking (Smoking and Health, 1987), physical inactivity (Powell, Thompson, Caslerson & Kendrick, 1987), and perhaps obesity and type A behavior (Haynes & Matthews, 1988). Some of the measures are complex. For example, there are at least five available measures of blood lipid, of which at least two may be clinically meaningful. Low Density Lipoprotein cholesterol (LDL) has been shown to have a positive association with heart disease and mortality. Conversely, High Density Lipoprotein cholesterol (HDL) has been shown to have a negative predictive value. The protective pattern includes relatively high HDL and relatively low LDL—or a favorable ratio of HDL to LDL of about 3.5 to 1. Poor social support has not been a traditional risk factor for heart disease. However, as we will argue, there is substantial evidence that interpersonal relationships may be related to health outcomes in heart disease.

STUDIES LINKING SOCIAL SUPPORT TO MORTALITY

At least 10 prospective studies have evaluated the relationship between close relationships and mortality. In the following sections we will review the data from these studies. Until the last decade, there was virtually no information on the relationship between social factors and mortality risk (Berkman, 1986). Thus, we are reviewing a relatively new, but rapidly developing, literature. Berkman (1985) has previously reviewed this literature. This chapter updates, refines, and expands upon her excellent contribution.

1. Alameda County. The Alameda County Study was a prospective evaluation of risk factors for all causes of death (Berkman & Syme, 1979). The study used questionnaires to evaluate 6,928 adult residents in a community in the San Francisco Bay area for various risk factors. This study is best known for establishing the relationship between health habits and mortality. It suggested that those who ate breakfast, did not smoke cigarettes, slept between seven and nine hours per night, exercised regularly, drank only moderate amounts of alcohol, etc. were more likely to live longer than those who had poorer health habits. In addition, the study also established interesting relationships between interpersonal relationships and longevity. The measures of social relationships, although crude, included whether or not a person was married along with degree
The study demonstrated a significant relationship between an index of social connectedness and longevity. Multivariate analysis was performed to adjust for potentially confounding effects of other variables such as physical health status, socioeconomic status, cigarette smoking, alcohol consumption, level of physical activity, obesity, race, life satisfaction, and use of preventive services. Considering the potentially confounding effects of these other variables, the age-adjusted relative risk for all causes of mortality was 2.3 for males and 2.8 for females over a nine-year mortality follow-up. In other words, men who were socially connected were 2.3 times more likely to survive nine years, and women who were socially connected were 2.8 times more likely to survive nine years than were their cohorts who scored lower on social connectedness. An index of satisfaction with marriage was found not to be associated with survival. The Alameda County Study focused on all-cause mortality. Yet, the effects still held for specific cardiovascular diseases, including coronary heart disease, and stroke (Bellocc & Breslow, 1972).

At the time the Alameda County study was designed, there was essentially no research on the relationship between social support and survival. The measures that were used in the study were, indeed, quite crude. Although the study has been faulted for not having sophisticated measures of social support, the investigators should be applauded for even considering such measures given that social factors had not been discussed in the literature prior to the study.

2. Tecumseh, Michigan. This study involved 2,754 men and women who lived in the community of Tecumseh, Michigan, a relatively rural community (House, Robbins & Metzner, 1982). Researchers obtained baseline measurements for all participants, ages 35-69, during the years 1967-1969. The participants were interviewed, examined, and followed for ten years. Social relationships were measured by indexes of marital status, number of visits with friends and relatives, and number of pleasurable activities, including drives and picnics. In addition, there were measures of formal organizational involvement which included going to church and attending various other formal organizations. The investigators considered leisure activities such as going to classes, movies and museums separately. Finally, passive and relatively solitary leisure activities such as watching TV, listening to the radio, or reading were also recorded. The investigators adjusted for age, cigarette smoking, alcohol consumption, education, employment status, occupation, weight, and height to evaluate the relationship between these social variables and health outcomes. The outcome measures were obtained during physical examinations. Then, physicians and staff estimated the occurrence of coronary heart disease, chronic bronchitis, high blood pressure, high cholesterol, diabetes, and lung disease.

There was a significant relationship between mortality from all causes and social relationship variables in the Tecumseh Study. After adjustment for age
and other risk factors, marital status, attendance at voluntary organizations, and
other leisure activities were significantly associated with survival in men. Interestingly, frequency of visits with friends and relatives and going out on
pleasure drives was not associated with survival for the men. The results were
somewhat different for women. For the females, church attendance was the only
significant correlate of all-cause mortality when adjustments for other risk
factors were employed. If the adjustments were only made for age, social activity
was related to mortality. However, the impact of the other relationships could
be explained through other risk factors. Interestingly, there was very little
evidence that satisfaction with social relationships or intensity of the relation-
ships was related to mortality. However, the reliability of the satisfaction
measure was questioned by the authors.

3. Durham County. Another major epidemiological study was conducted in
Durham County, North Carolina (Blazer, 1982). Investigators obtained data on
331 men and women 65 years or older using the Older American’s Resources
and Services (OARS) Social Support Scale. This questionnaire included three
dimensions relevant to social relationships: (1) roles and attachments such as
marital status, number of living children, and siblings, (2) frequency of interac-
tion with others as measured by the number of phone calls and visits, and (3)
perception of social support. The confounding variables in the Durham County
Study included age, sex, race, economic resources, physical health status,
activities of daily living, stressful life events, symptoms of major depressive
episodes, cognitive dysfunction, and cigarette smoking.

Mortality rates for the participants were followed and evaluated over a
30-month period in order to evaluate mortality. All three measures of social
relationships were significant predictors of mortality independent of the other
risk factors. Those with poor support had higher risks of dying. The risk ratio
was 2.04 for availability of support, 1.88 for frequency of interaction, and 3.40
for the relationship between perceived support and mortality. Those who
perceived their supportive environment as adequate were 3.4 times as likely to
survive 30 months as those who perceived it to be inadequate.

4. Evans County. The Evans County, Georgia study (Schoenbach, Kaplan,
Fredman & Kleinbaum, 1986) was a prospective cardiovascular epidemiologic
study. The original cohort of 3,102 Anglo and Black residents of the rural
population of Evans County was examined and interviewed in 1960. Investiga-
tors located and reexamined 2,530 of these subjects during the years 1967-1969.
In an effort to replicate the Berkman and Syme study of social networks and
mortality in Alameda County, sociologic interviews concerning education,
occupation, religion, marriage and family, worries, personal affiliations, and
spare time activities were obtained from 2,170 of the reexamined subjects. Vital
status follow-up of all subjects was conducted in May of 1980. At that time
complete social network and vital status data was available for 2,059 of the
subjects who had been examined in 1967-1969. A six-level social network index
modeled after the Berkman Social Network Index was constructed. The index considered information on the following seven items: marital status, number of relative families living nearby, number of close friends, number of neighbors the respondent knew well enough to visit, number of relative families seen often, frequency of church attendance, and spare time in church activities. For purposes of descriptive and stratified analysis, the six-level index was collapsed into four categories where 'I' indicated a low social network index and 'IV' indicated a high social network index. In addition, an alternative social network index was developed for some analyses. According to the authors, the alternative index utilized the same components but with simpler weighting. Unfortunately, the construction of the Social Support Network Index was not clearly presented in the published report.

Based on findings from Berkman and Syme, a specific statistical hypothesis testing procedure was chosen before beginning the analysis of the social ties-mortality relationship. This procedure utilized time-to-death as the dependent variable in a proportional hazards model, with the social network index variable as the exposure or independent variable. A number of physiologic and demographic variables were included as covariables. These control variables included age, presence of chronic disease, systolic blood pressure, cholesterol, smoking, Quetelet index, major and minor EKG abnormalities, social status, and leisure time physical activity.

A proportional hazards model multivariable analysis over all subjects yielded a hazard ratio of 1.6 (1.2-2.2) indicating that the social network variable was modestly predictive of survival. This effect was most pronounced among white males, where the age adjusted hazard ratio comparing the lowest to highest value on the six-level index was 2.0. Controlling for potential confounders (ie, cardiovascular disease risk factors) reduced the hazard ratio to 1.5. The social network effect for white females, black males and black females was nonsignificant. Further exploratory analyses indicated that marital status, church activities, and an alternate social network index predicted survival, but not in a clear dose response fashion. Perhaps the most important finding was that subjects above age 60 with few social ties had the highest risk of mortality.

The authors make several insightful comments regarding the relatively weaker effects for social support found in this study when compared to the Alameda County study. For example, as a rural community, the women and Blacks in Evans County are likely to have high social support index scores. In fact, the authors were developing the alternative social support index, they noted that only four per cent of their subjects had a score of zero, and they were forced to combine the two lowest social support levels. Thus, there may have been less variability for the whole range of the social support index for certain subgroups. Subtle wording differences between the two measures may also have yielded very different meanings in terms of social support. For example, the Alameda study obtained data on the number of relatives to whom the respondent felt close,
while the Evans County study obtained data on the number of related families living nearby. Finally, the specific social ties studied may have had different meanings in a fast paced, urban population such as Alameda County than in a predominately rural society such as Evans County where social ties are likely to have deep roots. Despite some of the problems of direct comparability across studies, the Evans County Study results are broadly consistent with the general hypothesis that social networks can be predictive of lowered mortality.

5. Japanese-American Men. Japanese-Americans are very interesting in studies of coronary heart disease. Rates of mortality from heart disease in Japan are extremely low—in contrast to very high rates in the United States. Evidence suggests that native Japanese who move to Hawaii or San Francisco begin to approximate the risks associated with residents of those areas (Marmot, Syme, Kagan, Kato, Cohen, & Belsky, 1975). Thus, habits and lifestyles are implicated in the risks of heart disease. Social affiliation was measured for 3,809 men between the ages of 30-74 years by looking at marital status, attendance at religious services, and membership in organizations. Social disconnection was defined as having a history of disruption in social ties. The confounding risk factors for heart disease included high blood serum cholesterol, high blood pressure, cigarette smoking, family history of heart disease, and lack of physical exercise. The data were analyzed using logistic risk analysis. Those who were highly affiliated were 1.94 times more likely to survive than those who were low in affiliation, when considering the cases at the extremes of social affiliation.

A related study considered 7,639 Japanese men living in Hawaii (Reed, McGee, Yano & Feinleib, 1983). These men were participants in the Honolulu Heart Study. They were initially examined between 1965-1968 and then resurveyed in 1971. In this study, social network was measured using a nine-item scale. The items considered geographic proximity of parents and in-laws, marital status, number of children, number of people in household, social activities, discussions of personal problems with co-workers, attendance at religious services, and number of social organizations regularly attended. Social networks were first evaluated considering all the variables and then evaluated separately for the first five items that dealt with more intimate social contacts. The co-variates in the study included blood pressure, serum cholesterol, serum glucose, cigarette smoking, alcohol consumption, physical activity and body mass.

In evaluating the association of social relationships to cardiovascular disease, prevalence and incidence data were analyzed. The results of the prevalence data suggested that the Index of Close Social Relationships was correlated with angina pectoris but not MI. Considering the prospective prediction of heart disease, the items concerning closer social relationships were marginally associated with non-fatal MI. Those individuals who reported fewer intimate social contacts were 1.5 times more likely to suffer from a non-fatal MI. The size of the effect was weaker than that observed in some other studies.
6. Framingham, Massachusetts. The social support portion of the Framingham Heart study evaluated only a portion of their large (N = 5,127) cohort. The participants evaluated for social support included 142 female clerical workers. Measures of social support included whether or not the woman had a non-supportive boss (Haynes & Feinleib, 1980). The risk factors were the standard ones (blood cholesterol, blood glucose, cigarette smoking, high blood pressure, obesity). In addition, the Framingham investigators adjusted for anger, changes on the job, and number of family responsibilities. Over an eight-year follow-up period, only female clerical workers with non-supportive bosses were found to be at increased risk for cardiovascular disease, defined in this study as myocardial infarction, angina pectoris, or death.

7. Israel. Several studies have been conducted in other western cultures. An interesting study has been reported by a group of Israeli investigators (Medalie & Goldbourt, 1976). In this study 10,000 Israeli adult male civil service and municipal employees were followed over a 5-year period. Two measures of social support were used. The first measure included family difficulties, such as conflicts with other family members. The second measure was an indication of the wife’s love and support. In order to control for confounding variables, the investigators included measures of age, high blood pressure, anxiety, serum cholesterol, diabetes, and EKG abnormalities.

The results suggested that family problems were an important predictor of angina pectoris. In addition, in anxiety provoking situations, men who did not have the love and support of their wives were found to have 1.8 times the risk of angina pectoris as those who felt they had their wife’s love and support.

8. Gothenburg, Sweden. A study from Sweden also supports the relationship between social support and health outcome (Welin et al., 1985). In 1963, the investigators began a prospective study of 855 men born in 1913 to assess the association between hypertension, hypercholesterolemia, smoking and alcohol consumption and the development of heart disease. The follow-up exams in 1973-74 included the addition of questionnaires to obtain detailed information about the subject’s social connections and activities. At this time, a new sample of subjects born in 1913 were drawn from the population register in Gothenburg, Sweden. The new sample included all of the men from the 1963 study who were still alive and living in Gothenberg as well as new men who had since moved into the area. In addition, a random sample of 292 men born in 1923 was drawn from the registry. Both groups of men were invited for 2½ days of examination. During the first half day, data were collected on traditional CHD risk factors including blood pressure, cholesterol, smoking and alcohol consumption. A second half day examination was devoted to collection of detailed social variables including number of persons in the home, marital status, health status, home and outside home social activities. Nine hundred eighty-nine of the men completed questionnaires and interviews regarding social variables.
Mortality data were collected from 1973 until the end of 1982. During the nine-year period, 134 of the 769 participants born in 1913 and 17 of the 220 participants born in 1923 had died. For both samples, the higher the outside home activity and social activity the lower the mortality. In addition, the more persons living in the home, the lower the mortality. The association between social activity and mortality was strong even when other variables such as age and other CHD risk factors were taken into account (Welin et al., 1985).

9. Swedish Mortality Registry. A recent study evaluated cardiovascular mortality among 17,433 Swedish men and women who were between the ages of 29 and 74 during a six-year follow-up period. Participants in the study had been interviewed about their social relationships. The social context score was created to represent availability of people in a social network. The Swedish government obtained an extensive mortality registry which was used to determine which members of the cohort had died during the six-year period. There were 841 deaths during this follow-up. The unadjusted risk ratio for individuals in the lower tertile (as compared to the upper two tertiles) was 3.7. However, much of this association was reduced when other statistical controls were introduced. Adjusting for age reduced the risk ratio to 1.46. With controls for age, smoking, exercise, and chronic illness, the risk ratio was reduced to 1.34. However, this value was still statistically significant ($p < .03$) (Orth-Gomer & Johnson, 1987).

10. Beta Blocker Heart Attack Trial. The previous sections considered groups who were free of heart disease at the beginning of the study. The Beta Blocker Heart Attack Trial (BHAT), a multicenter, randomized, double-blind, placebo-controlled study investigated the effects of propranolol hydrochloride (a beta blocker medication) on mortality rates during a two to four-year period in men and women who had suffered at least one myocardial infarction. In an ancillary study concerned with the role of psychosocial factors on mortality after myocardial infarction, 2,323 male survivors, 30 to 69 years of age, completed a questionnaire two to three months after a myocardial infarction. The questionnaire included the following psychosocial parameters: (1) the ease and extent of communication between the patient and his family and relatives; (2) indicators of the patient's social relatedness; and (3) the occurrence of and reaction to specific types of life crises. Twenty questionnaire items were used to derive four factors through multivariate factor analysis. Of the four factors, two defined psychosocial variables, relatively high levels of stress and relatively high levels of social isolation, made significant independent contributions to the risk of death over a period of three years. Controlling for standard risk factors, the risk of death associated with high levels of both life stress and social isolation was four to five times that for men in whom both those categories were low. In addition, the authors reported an inverse relationship between high levels of stress, social isolation and educational level. High levels of stress and isolation
were found more often in men with low education and least often among the more educated men (Ruberman, Weinblatt, Goldberg, & Chaudhary, 1984).

**METHODOLOGICAL ISSUES IN EPIDEMIOLOGICAL RESEARCH**

Research on the association between close interpersonal relationships and coronary heart disease is intriguing. Although few systematic studies have been conducted at this time, we believe this is an interesting area for future investigation. Before research can proceed, however, methods used in this field need to be sharpened. To accomplish this, we must consider issues such as the measurement of social support and the adequacy of the multivariate models applied in this field.

**Measurement of Social Support**

One of the major problems in comparing studies on social relationships and health is that the measures are inconsistent across studies. Epidemiologic studies tend to use simple measures of network size. In contrast, contemporary psychologists use more sophisticated measures of social support. The rapidly expanding literature documents the effects of social support on both physical and psychological health. Most contemporary measures of social support include both tangible components such as financial assistance and physical aid and intangible aspects including encouragement and guidance. To some extent, the inconsistent findings often reported in the literature may be associated with the wide diversity of social support scales that have been used in different studies. Recently, Heitzmann and Kaplan (1988) found 23 different techniques that had been used to assess social support. In many cases there were no psychometric data available to evaluate the measures. Among the scales that did have psychometric data, the reliability ranged from .22 to .98. Validity data were reported in only about one half of the studies. The content of the items in different scales varies widely. It is very difficult to make comparisons across studies because the exact items used to assess social relationships are almost never uniform across studies.

**Causal Modeling**

The relationship between social support and mortality is indeed impressive. However, the relationships are primarily correlational. There are at least three rival explanations for the association between the presence of social relationships and mortality. First, there is the assumed explanation that the correlation
between social support and cardiovascular disease is causal: high support protects against illness. The second explanation is that individuals who are sick drive away their social support system. This suggests that early illness causes changes in social support. This issue is considered in the Chapter by Lyons (this volume). A third explanation is that a third variable, such as social class, personality, etc., causes both poor social support and poor health outcomes. We will review the later two alternatives first, and then return to the theme that social support protects against CHD mortality.

1. Illness Causes Disruption in Social Support. Illness can cause modifications in the support environment. Studies of asthma, cancer, and other diseases are common stimuli for alterations in family environment. For example, heart patients may be victimized by family members and friends. These potential supporters may feel uncomfortable interacting with someone who is impaired (Wortman & Dunkel-Schetter, 1979). Disturbance in marital relationships often follow diagnosis and treatment of serious conditions such as heart disease. Spouses may be overly concerned or the family may not want to invest emotional resources in someone who is not likely to survive.

Epidemiologic studies often attempt to control for disease severity. However, measures of disease severity are often inadequate. When controls for health status are entered into multivariate equations, it is likely that the analyses will underadjust because the measures of health status simply do not reliably capture the construct. Another issue is that early phases of heart disease may interfere with social relationships. Affected persons may not be interested in walking, dancing, or leisure activities, and these may be the early symptoms of the undiagnosed condition. Although this direction of causation seems plausible, we will suggest later that prospective studies considering temporal relationships tend to disconfirm that the causal direction goes from illness to reduced support.

2. Third Variable Explanations. An alternative explanation for the relationship between social relationships and mortality from heart disease involves third variables of which a variety have been postulated. For example, poverty and social class are remarkably strong predictors of death from coronary heart disease (Kaplan, 1985). Individuals of lower socioeconomic status may be subjected to demanding and unrewarding work situations in which they have little control over their environment. These situations have been postulated as predictive of coronary heart disease (Karasek, Baker, Marxer, Ahlbom & Theorell, 1981). In addition, evidence suggests that low income families are exposed to greater levels of environmental insult. For instance, National Center for Health Statistics data reveal a relationship between blood lead levels and family income, race, and degree of urbanization (Mahaffey, Annest, Roberts & Murphy, 1982). Living in these difficult circumstances may cause both disruptions in social support and may independently cause heart disease.

A related third variable explanation is that there is a health practices channel. The Alameda County Study identified a variety of health practices as predictive
of coronary heart disease mortality (Belloc & Breslow, 1972). It is possible that those with poor health habits have difficulty obtaining social support, and these health habits independently predict mortality.

Finally, Type A behavior has been postulated as a third variable that may explain the relationship between social relationships and health outcomes. Individuals with Type A personalities are difficult to get along with. They are temperamental, reactive, and impatient. Since Type A personality is believed to independently predict heart disease, it seems plausible that a difficult personality could cause both poor social interaction and risk for mortality.

Some evidence refutes each of these third variable explanations. Although the literature on kin relationships and socioeconomic status is a rich one (Stack, 1974), there is not convincing evidence that low socioeconomic status individuals have poorer social support than do high socioeconomic status individuals. In both the Evans County and the Tecumseh Michigan Study, low income Black participants were well integrated into stable rural communities. Social support scores for these groups tended to be very high despite their elevated risk for coronary heart disease (Schoenbach, Kaplan, Fredman & Kleinbaum, 1986; House, Robbins, & Metzner, 1982). Further, studies adjusting for socioeconomic status in multivariate analyses suggest that the gradient of association between close relationships and mortality exist even when socioeconomic status is statistically controlled.

Similar data have been presented for the effects of health habits. Virtually all of the studies described above had statistical controls for smoking, dietary fat, obesity, etc. The Alameda County Study (Belloc & Breslow, 1972) systematically controlled for health habits, yet still found the relationship between personal relationships and mortality. Type A behavior seems an unlikely third variable at this point. For many years, Type A behavior was believed to be a significant risk factor for coronary heart disease. The behavioral medicine literature began focusing on correlates of the Type A behavior pattern and ignoring a rising tide of evidence that Type A behavior was not related to mortality. The Multiple Risk Factors Intervention Trial (MRFIT) failed to show any association between Type A behavior pattern and mortality. Most recently, Ragland and Brand (1988) found that individuals with Type A personalities actually had a better chance of surviving a myocardial infarction than members of the cohort who were Type Bs.

Third variable explanations cannot be ruled out. Indeed, we have only considered a few of the many potential third variables that could explain the association between personal relationships and mortality. However, we find little current evidence to support the third variable explanations most commonly postulated in the literature. Since this is not an area of experimental investigation, it is difficult, if not impossible, to rule out third variable explanations.

3. Low Social Support Causes Mortality. Upon review, we suggest that there is a causal relationship between social support and mortality. Epidemiologists
do not often use experimental data. Instead, they use a variety of criteria to estimate the plausibility of causal interpretation. These criteria include temporality, strength of association, consistency, gradient, and biological plausibility.

- **TEMPORALITY**—Temporality occurs when the cause precedes the outcome. In this review we are considering only studies that prospectively evaluated the relationship. In each of these studies the measurement of social support occurred prior to the coronary heart disease event. Particularly in the case of mortality, it is impossible for the events to precede the measurement of social relationships.

- **STRENGTH**—The strength of association between social support and outcomes varies from study to study. However, the strength is typically within the range of other risk factors for coronary heart disease. We will return to a discussion of the strength of association in the next section.

- **CONSISTENCY**—The association between social relationships and mortality is consistent across studies. The effects have been shown for urban and rural populations as well as for men and women. They have also been observed in several western cultures. However, not all studies demonstrate the effect for men and women within the same cohort (Berkman, 1986). The direction of effect has been consistent across studies. There appear to be no studies in which availability of social relationships is associated with increased mortality.

- **GRADIENT**—For some, but not all, biologic outcomes there is a gradient between the exposure to the risk factor and likelihood of the outcome. For example, there is a systematic relationship between number of cigarettes smoked and mortality. There is also a systematic relationship between serum cholesterol and mortality and a similar relationship between blood pressure and mortality. There is also some evidence for this type of gradient effect for social contacts. Several of the studies (Welin et al., 1985; Blazer, 1982; Berkman & Syme, 1979; House et al., 1982; Schoenbach et al., 1986) obtained a systematic relationship between number and frequency of social contacts and mortality. This relationship is not as well established for perceived quality of social support.

- **BIOLOGICAL PLAUSIBILITY**—The argument that a risk factor causes a health outcome must include some reasonable biological explanation for the association. Although studies in this area are not well developed, preliminary evidence identifies relationships between social factors and hemodynamic disruptions with the sympathetic-adrenal medullary reactions to stress. These studies have been suggested by analyses of human data and confirmed with animal models (Manuck, Kaplan, Adams, & Clarksen, 1988). Other lines of research demonstrate the impact of loneliness upon immune function (Kiecolt-Glaser, Garner, Speicher, Penn, Holliday & Glaser, 1984).
In summary, there are at least three alternative causal models to explain the relationship between social support and coronary heart disease. The observational nature of epidemiological data does not allow a definitive choice between the alternative explanations. However, we believe that current data support the notion that social support is protective against coronary heart disease.

**STRENGTH OF ASSOCIATION**

One of the methodological issues is the strength of association. Table 1 (p. 222) summarizes the strength of association across the various studies considering social support. Table 2 (p. 223) presents risk ratios across studies of traditional risk factors. As the tables suggest, low social support is a risk factor, and the strength of this risk factor is comparable to most other established risk factors.

Given the emerging evidence that social support is a risk factor for health outcomes and cardiovascular disease in particular, it is unfortunate that relatively few researchers are systematically investigating this relationship. Intervention at this level may prove to be as profitable as existing preventive measures aimed at dietary modification or stress reduction. The relative risks for traditional coronary heart disease risk factors are rarely over three (3.0). Indeed, cigarette smoking, the largest controllable risk for coronary heart disease, nearly always has a mortality ratio less than 2.0. In other words, smokers are about twice as likely to die of heart disease than are non-smokers over periods of about 10 years. In comparison to other risk factors, the strength of association for mortality among the socially isolated is at least as strong as it is for those who have other risk factors.

It is interesting to consider the strength of association for social support in relation to variables that the public perceives as major risks for coronary heart disease. For example, there is a strong relationship between serum cholesterol and mortality, although the relationship between diet and serum cholesterol has been difficult to demonstrate (Stallones, 1983). Cross-cultural studies have demonstrated ecologic correlations between dietary habits and mortality, yet there have been only a few studies that have demonstrated a correlation between dietary and serum cholesterol within countries. Further, studies within countries have not demonstrated a direct relationship between dietary habits and mortality (Kaplan, 1985). There are many alternative explanations for these rather weak effects. Many epidemiologists believe that measurement error in dietary cholesterol can account for the failure to find a relationship, yet existent data provide very little evidence for a relationship between dietary cholesterol and mortality. Nevertheless, sources ranging from the American Heart Association to the popular media consistently advise adults to lower their dietary intake of cholesterol in order to avoid death by heart disease. Stallones (1983) points out that the risk ratio for comparing those who eat high with those who eat low levels
### Table 1. Strength of Association Across Studies.

<table>
<thead>
<tr>
<th>Study</th>
<th>N</th>
<th>SS Measure</th>
<th>Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alameda County * ^ ~</td>
<td>6928</td>
<td>Marital status/satisfaction. Contacts w/ family/friends. Church attendance. Social affiliations.</td>
<td>↑SS associated with ↑ longevity. Males with ↑ SS 2.3x and females with ↑ SS 2.8x more likely to survive nine years.</td>
</tr>
<tr>
<td>Tecumseh Study * ^ ~</td>
<td>2754</td>
<td>Marital status. # of visits w/ family/friends. # of pleasurable activities. Church attendance. Voluntary organizations. Leisure activities.</td>
<td>↑SS associated with marital status, voluntary rates in activities predicted survival rates in males. For females, only church attendance significantly associated with survival.</td>
</tr>
<tr>
<td>Durham County * ~</td>
<td>331</td>
<td>Marital status. # of living children. # of siblings. Frequency of interaction. Perception of support.</td>
<td>↑SS associated with ↓ mortality risk over a 30-month period. Those who perceived their environment to be adequate were 3.4x as likely to survive 30 months.</td>
</tr>
<tr>
<td>Evans County * ~</td>
<td>2059</td>
<td>Marital status. # of relative families nearby. # of relative families seen often. # of close friends. # of close neighbors. Church attendance. Spare time in church activities.</td>
<td>Social network variable was modestly predictive of survival. This effect was most pronounced among white males. The social network effect for white females, black males, and black females was not significant.</td>
</tr>
<tr>
<td>Japanese-American Men in San Francisco * ^ ~</td>
<td>3809</td>
<td>Marital status. Church attendance. Membership in organizations.</td>
<td>↑SS associated with ↑ survival rates. Those with ↑ SS 1.94x more likely to survive.</td>
</tr>
<tr>
<td>Japanese-American Men in Hawaii * ^ ~</td>
<td>7639</td>
<td>Proximity of parents and in-laws. Marital status. # of children. # in household. Social activities. Church attendance. Social organizations. Discuss problems with coworkers.</td>
<td>Examined incidence and prevalence data. Closer social relationships correlated with angina pectoris. Those men reporting more intimate social contacts were 1.5 times more likely to suffer from a non-fatal myocardial infarction.</td>
</tr>
<tr>
<td>Framingham Study * ^</td>
<td>142</td>
<td>Non-supportive boss.</td>
<td>Only female clerical workers were studied. ↓ SS (non-supportive bosses) associated with ↑ cardiovascular disease.</td>
</tr>
<tr>
<td>Israeli Ischemic Study * ^</td>
<td>10,000</td>
<td>Family difficulties. Wife's love and support.</td>
<td>Only male civil service workers were studied. Males with ↓ SS from wives 1.8x more likely to have angina pectoris in anxiety provoking situations. Family difficulties were an important predictor of angina pectoris.</td>
</tr>
<tr>
<td>Gothenburg Study * ^</td>
<td>989</td>
<td>Marital status. # of persons in home. Social activities.</td>
<td>Studied males only. ↑ SS was associated with ↓ mortality.</td>
</tr>
</tbody>
</table>
### Table 2. Relative Risk Ratios of common risk factors for cardiovascular disease.

<table>
<thead>
<tr>
<th>RISK FACTOR</th>
<th>DEFINITION</th>
<th>RATIO</th>
<th>REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cigarette Smoking</td>
<td>None vs. 15-24/day</td>
<td>1.58</td>
<td>Doll &amp; Peto, 1976</td>
</tr>
<tr>
<td></td>
<td>None vs. 20/day</td>
<td>1.70</td>
<td>Pooling Project, 1978</td>
</tr>
<tr>
<td></td>
<td>None vs. 15-24/day</td>
<td>2.20</td>
<td>Doll et al., 1980</td>
</tr>
<tr>
<td></td>
<td>Never vs. Ever</td>
<td>1.90</td>
<td>Wingard, 1982</td>
</tr>
<tr>
<td>LDL Cholesterol</td>
<td>Increase of 20 mg/dl</td>
<td>1.07</td>
<td>MRFT/SI group, 1986</td>
</tr>
<tr>
<td></td>
<td>Increase of 20 mg/dl</td>
<td>1.13</td>
<td>MRFT/SI group, 1986</td>
</tr>
<tr>
<td></td>
<td>Lowest vs. Highest quintile</td>
<td>1.29</td>
<td>MRFT/SI group, 1986</td>
</tr>
<tr>
<td></td>
<td>Lowest vs. Highest quintile</td>
<td>1.51</td>
<td>MRFT/SI group, 1986</td>
</tr>
<tr>
<td>HDL Cholesterol</td>
<td>Increase in 5 mg/dl</td>
<td>1.00</td>
<td>MRFT/SI group, 1986</td>
</tr>
<tr>
<td></td>
<td>Increase in 5 mg/dl</td>
<td>0.97</td>
<td>MRFT/SI group, 1986</td>
</tr>
<tr>
<td></td>
<td>Lowest vs. Highest quintile</td>
<td>0.98</td>
<td>MRFT/SI group, 1986</td>
</tr>
<tr>
<td></td>
<td>Lowest vs. Highest quintile</td>
<td>0.84</td>
<td>MRFT/SI group, 1986</td>
</tr>
<tr>
<td>Body Mass Index</td>
<td>Increase in 5 kg/m²</td>
<td>1.14</td>
<td>MRFT/SI group, 1986</td>
</tr>
<tr>
<td></td>
<td>Increase in 5 kg/m²</td>
<td>1.02</td>
<td>MRFT/SI group, 1986</td>
</tr>
<tr>
<td></td>
<td>Lowest vs. Highest quintile</td>
<td>1.09</td>
<td>MRFT/SI group, 1986</td>
</tr>
<tr>
<td></td>
<td>Lowest vs. Highest quintile</td>
<td>1.18</td>
<td>MRFT/SI group, 1986</td>
</tr>
<tr>
<td></td>
<td>Under (9.9%) vs. Over (29.9%)</td>
<td>1.20</td>
<td>Wingard et al., 1982</td>
</tr>
<tr>
<td>Alcohol consumption</td>
<td>None vs. 1 drink/day</td>
<td>1.00</td>
<td>Dyer et al., 1980</td>
</tr>
<tr>
<td></td>
<td>None vs. 2-3 drinks/day</td>
<td>0.90</td>
<td>Dyer et al., 1980</td>
</tr>
<tr>
<td></td>
<td>None vs. 4-5 drinks/day</td>
<td>0.70</td>
<td>Dyer et al., 1980</td>
</tr>
<tr>
<td></td>
<td>None vs. 6+ drinks/day</td>
<td>2.00</td>
<td>Dyer et al., 1980</td>
</tr>
<tr>
<td></td>
<td>None vs. 0-29 oz/month</td>
<td>1.00</td>
<td>Stason et al., 1976</td>
</tr>
<tr>
<td></td>
<td>None vs. 30+ oz/month</td>
<td>0.70</td>
<td>Stason et al., 1976</td>
</tr>
<tr>
<td></td>
<td>High (&gt;45 drinks) vs. Low</td>
<td>1.50</td>
<td>Wingard, 1982</td>
</tr>
<tr>
<td>Physical Activity</td>
<td>Inactive vs. Active</td>
<td>1.40</td>
<td>Wingard, 1982</td>
</tr>
<tr>
<td>Contacts with friends</td>
<td>Few vs. Many</td>
<td>1.70</td>
<td>Wingard, 1982</td>
</tr>
</tbody>
</table>
of dietary cholesterol is very near to 1.0. In contrast, the studies on social relationships consistently show risk ratios above 2.0. Despite these findings, popular discussions of risk factors for heart disease rarely, if ever, mention social support.

POTENTIAL MECHANISMS

The mechanism whereby close relationships protect against coronary heart disease is not well understood. Cohen and Syme (1985) identified at least two rival explanations for this relationship. Two models, the Main-effects Model and the Stress-buffering Model, differ in their views of the importance of stress. The Stress-Buffering Model assumes that stress leads to poor health outcomes and that social relationships buffer the impact of stress. The Main-Effects Model assumes that social relationships influence health outcomes and stress is only one of several factors that impact upon health.

1. The Main-Effects Model. The Main-Effects Model suggests that stress is not the only important variable influencing health outcomes. Instead, social relationships enhance health and well-being independently of stress. There are a variety of ways that social relationships may directly affect health outcomes. One is through support for health-promoting behaviors. Social relationships influence behaviors and these behaviors in turn promote desirable health outcomes. Another interpretation is that social involvement provides identity and sources of positive self-evaluation. This may enhance the perception of control and mastery and reduce the experience of anxiety (Thoits, 1985). Reduction in anxiety, helplessness, and despair may result in enhanced health outcomes.

Considering some of the research linking social support directly to health behaviors, Kaplan and Toshima (1990) reviewed the literature on the relationship between social support and health for chronically ill adults. They found the associations between social relationships and health outcomes to be very mixed. Some studies showed a positive benefit of social support, some showed that social relationships were associated with poorer health outcomes, and some studies were neutral. However, studies showing a positive benefit of social support tended to use outcome measures of health behaviors such as compliance with anti-hypertensive medications, or compliance with a complex regimen for diabetic patients. Other studies have shown that supportive partners may help prevent relapse in smoking cessation programs or may be associated with improved outcomes in weight loss programs (Brownell, Heckerman, Westlake, Hayes & Monit, 1978; Dubbert & Wilson, 1984).

The Main-Effects model is a compelling explanation for the relationship between social support and health outcomes. Substantial evidence suggests that behaviors are predictive of mortality from cardiovascular disease (Kaplan & Stamler, 1983). Further, health habits aggregate within families (Patterson,
Kaplan, Sallis & Nader, 1987) and it seems reasonable that health outcomes will be enhanced by any support. However, studies on the relationship between support and health behaviors have not always been consistent (Malott, Glasgow, O'Neill & Klesges, 1984).

Studies demonstrating the relationship between support of behaviors and health habits have suggested that behaviors of the supportive person are specific rather than general. In other words, members of the support environment may reinforce specific health habits rather than being generally supportive. For example, Sallis, Grossman, Pinsky, Patterson and Nader (1987) found that specific social support items correlated with diet and exercise behaviors. However, a general measure of social support was unrelated to either the support for specific health behaviors or an enactment of those behaviors. Schafer, McCaul and Glasgow (1986) also found that adherence to a diabetic regimen was related to specific rather than generalized aspects of social support.

Although the Main-Effects Model appears to be a plausible explanation for the relationship between social support and health outcomes, several lines of evidence challenge it. First, not all studies on social support and health outcomes are consistent (Kaplan & Toshima, 1990). Further, the epidemiologic studies linking close relationships to mortality tend to show that the association is with social connectedness (network size) rather than satisfaction with relationships. There is little evidence that these large networks specifically support making life changes or changing exercise patterns, such as stopping smoking.

Perhaps the most important challenge to the Main-Effects Model is that major epidemiologic studies parcel out the variance associated with health habits. Thus, to the extent that health habits can be measured, they are controlled in the analysis. The effect of close relationships remains even after the habits of those in the social network are removed. In summary, the Main-Effects Model does appear plausible. However, there are also reasons to doubt that it will fully explain the association between close relationships and health outcomes.

2. The Stress-Buffering Model. Perhaps the leading model used to describe the protective effects of close relationships is the Stress-Buffering Model. Proponents of this model assume that psychological stress has pathogenic effects. Cohen and Syme (1985) described two different ways the model may work. First, social support may intervene in the pathway between the stressful event and the receiver. Members of the social environment may help reinterpret the event or aid in modifying the threat value of the event. The second point at which social support may effect stress is between the response to the stress and the outcome. Members of the support environment might help tranquilize the stressed individual or aid in the coping process.

Cohen and Syme (1985) made an important distinction between structural and functional perspectives on support. Functionalists consider the functions of close relationships. For example, functionalists measure whether interpersonal relationships serve certain functions, provide affection, or support specific
behaviors. Structuralists focus on the existence of interconnections and generally measure characteristics of network size. Different researchers have tended to choose either a functional or a structural approach to their investigations. Most of the research on the Buffering Model is in the functionalist tradition.

There are several lines of evidence that question the Buffering Model as the most plausible explanation for the support-mortality relationship. One of the most important challenges is that the stress-mortality connection for heart disease is not necessarily clear. At least two different models have been proposed to suggest that stress causes CHD mortality. One model argues that stress affects biochemical processes associated with atherosclerosis. For example, Dimsdale (1985) has argued that psychological stress can increase serum lipids. Serum lipids, in turn, are a well documented risk factor for coronary heart disease. However, not all studies support the stress-lipid hypothesis. Indeed, Dimsdale (1985) acknowledged that there are inconsistencies in the data. Recently, Niaura and colleagues (1988) failed to show that accountants under tremendous stress at tax time had any rise in serum lipids. Similarly, the relationship between stress and blood pressure has been variable across studies (Haynes & Matthews, 1988).

Another argument favoring a stress-heart disease relationship is centered on the stress-prone Type A personality. The original evidence for the relationship between Type A behavior and heart disease comes from a prospective study known as the Western Collaborative Group Study. This investigation followed 3,154 healthy men for 8.5 years. Those who were categorized as Type A were almost twice as likely to have coronary artery disease in comparison to those who were classified in the Type B pattern. This relationship existed even with controls for other risk factors (Rosenman, Brand, Jenkins, Friedman, Straus & Wurm, 1975). The other major line of evidence for the Type A hypothesis came from Coronary Angiography studies. At least three different groups found that those with Type A personalities had more occlusions of their arteries (Zyzanski, Everist, Flessas, Jenkins & Ryan, 1976; Blumenthal, Williams, Kong, Shanberg, & Thompson, 1978; Frank, Heller, Kornfeld, Sporn & Weiss, 1978). Unfortunately, the Type A hypothesis has fallen into disfavor in recent years. A recent meta-analysis of Type A studies suggested that studies published after 1977 were much less likely to find a detrimental effect of Type A behavior and that cross sectional studies are more likely to find the effect than prospective studies (Booth-Kewley & Friedman, 1987). Perhaps the most damaging data were published in a recent study suggesting that those with Type A personality patterns were more likely to survive a myocardial infarction than those with Type B pattern (Ragland & Brand, 1988). Interestingly, this analysis used the same data set that was previously analyzed to support the Type A hypothesis. As Dimsdale (1988) suggested, 'This is a topsy-turvy career for a risk factor' (p. 110). The Type A studies bring into question the real role of stress as a predictor of coronary heart disease. Indeed, the stress-mortality hypothesis is
not consistently documented in the literature. If stress does not serve as the major variable causing mortality, then the buffering hypothesis is difficult to embrace.

Most epidemiologic studies supporting the social support-mortality relationship have not been designed to test the buffering hypothesis. Indeed, buffering has not consistently been supported when attempts have been made to evaluate it (Reed et al., 1983).

We do not wish to suggest that both the Main-Effects and Stress-Buffering explanations can be ruled out. However, we do believe more complex models may be required to explain the data. One such approach is a modified Main-effects model that considers the functional effects of social environment. The social environment may have either positive or negative effects upon health behavior (Kaplan & Toshima, 1990). However, we would expect that close, caring relationships would play a stronger role in reinforcing health behavior and in enhancing use of the health care system. At the other extreme, social isolation might contribute to disconnection with services, poor nutrition, and inadequate response to emergencies. The available data may allow comparisons between isolation and non-isolation. Newer, richer data sets will be required to separate positive from negative influences for those with some social network.

**SUMMARY**

In summary, there appears to be rather consistent evidence that close relationships are associated with protection from death due to coronary heart disease. Considering the alternative hypotheses, it seems most likely that this relationship is causal. Mechanisms relating social support to health outcomes have not been clearly documented. Neither the Main-Effects nor the Stress-Buffering Model can clearly account for the results. The relationship between social variables and health outcomes will be a major challenge for both social psychologists and epidemiologists.

As shown in Table 2, the association between poor social support and mortality is of comparable magnitude to many established risk factors. At this point, questions abound and answers are few. Most epidemiologic investigations were not planned to consider social factors. As a result, measures in existent data bases are crude. Yet the involvement of social scientists in epidemiological investigations is rapidly changing this pattern. New prospective studies are obtaining the data needed to address these questions. With new data, investigators can evaluate the role of social contacts versus intimacy, the casual pathways, and relationships between support and immune function. The relationship between epidemiology and social psychology is an important one. We encourage more investigators to become involved in this exciting area of research.
REFERENCES


The Epidemiology of Cardiovascular Disease


