What really matters in the social network–mortality association? A multivariate examination among older Jewish-Israelis

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Published online: 22 May 2007
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Abstract The aim of the inquiry was to examine the social network–mortality association within a wider multivariate context that accounts for the effects of background framing forces and psychobiological pathways. The inquiry was based upon the Berkman et al. (2000) conceptual model of the determinants of health. Its main purpose was to identify the salient network correlates of 7-year all cause mortality among Jewish men and women, aged 70 and over, in Israel ($n = 1,811$). The investigation utilized baseline data from a national household survey of older adults from 1997 that was linked to records from the National Death Registry, updated through 2004. At the time of the study, 38% of the sample had died. Multivariate Cox hazard regressions identified two main network-related components as predictors of survival: contact with friends, a social network interaction variable, and attendance at a synagogue, a social engagement variable. Friendship ties are seen to uniquely reduce mortality risk because they are based on choice in nature, and reflect a sense of personal control. Synagogue attendance is seen to promote survival mainly through its function as a source of communal attachment and, perhaps, as a reflection of spirituality as well. Other possibly network-related correlates of mortality were also noted in the current analysis—the receipt of instrumental support and the state of childlessness.

Keywords Mortality · Social network · Friends · Synagogue · Jews · Israel

Introduction

This investigation seeks to clarify the association of social networks and mortality in later-life. It extends a conceptual framework proffered by Berkman et al. (2000) for the structured study of health, to an analysis of mortality risk. Its purpose is to shed light as to which components of the social network best promote survival in old age. The analysis focuses upon veteran Jewish-Israelis, who comprise 74% of the cohort aged 70 and over in Israel.

As noted, Berkman et al. formulated a conceptual model that postulates how social networks affect health. The paradigm claims a cascading causal process in which macro-social framing forces influence social network structure and interaction, which in turn, set psychosocial mechanisms into motion. These processes subsequently work through psychobiological processes to influence health.

The background framing forces that begin the process include socioeconomic statuses. Of particular interest, in this regard, are statuses that lead to inequality over the life course, such as those which result from educational and income disparities. The psychobiological processes that end the process, on the other hand, include health-promotion and/or risk behavior, such as physical exercise and smoking, cognitive and emotional states, such as self-esteem or depression and physiologic pathways such as morbidity.

Between these two endpoints in the conceptual paradigm lies the realm of social network. Indeed, a major contribution of the model is its detailed delineation of networks and its explication of their resultant psychosocial outcomes. The model conceptualizes social network in terms of

The study on which this article is based was made possible by grants from the Israel Ministry of Science and Technology to the Israel Gerontological Data Center.

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structure and interaction and links these network components to psychosocial mechanisms. Network structure is operationalized through such measures as size and composition. Network interaction is reflected by such measures as frequency of contact and reciprocity of ties. Of equal importance is the paradigm's contention that social networks activate psychosocial processes that affect, in turn, health behaviors and outcomes. The most noted of these processes is the provision of social support, measured in the current analysis as the exchange of instrumental and financial support. However, network structure and interaction shape additional psychosocial processes, including social influence, social engagement and access to resources.

While the model offers a broad framework through which to examine the effect of social networks on health, however, it also presents some methodological challenges. As the theorists themselves contend, not all components of the paradigm are mutually exclusive and some may operate simultaneously. This complicates the ability to delineate specific paths of influence. Thus, for example, the model cites frequency of organizational participation as both an indicator of social network interaction and as a measure of psychosocial mechanisms (social engagement). Similarly, the model considers reciprocity as a social network interaction variable, but such interaction also reflects the exchange of social support, another psychosocial process indicator. Empirical inquiry is required in order to sort out the nature and the effect of these key variables that influence health.

Social networks and mortality risk

As noted, the present inquiry applies the Berkman model in order to better understand how social networks influence mortality. Landmark research initially demonstrated the association of social network and mortality (Berkman and Syme 1979; House et al. 1982). More recent works have continued to confirm the association (Orth-Gomer and Johnson 1987; Sugisawa et al. 1994; Yasuda et al. 1997). Nonetheless, there are studies that challenge the association between social network and mortality (Shahtahmasebi et al. 1992; Wen et al. 2005), or note its confoundedness with other variables, particularly health (Rutledge et al. 2003).

In addition, a review of the "social network–mortality association" among the oldest-old indicates that the findings for this group tend to vary. Thus, for example, a prospective Swiss study of octogenarians found that the presence of siblings and close friends in this population was indeed a significant predictor of 10-year survival, after controlling for the effects of socio-demographic background and health (Guilley et al. 2005). Moreover, the study clarified that frequency of contact was a less important predictor of survival than was the nature of the social tie. Another

interesting finding from this study was that the presence of a spouse did not predict survival.

Different results were obtained in a Danish prospective study of twins aged 75 years and older (Rasulo et al. 2005). Here, the presence of a spouse was found to extend survival. On the other hand, the contribution of interaction with friends for survival was only partially confirmed. That is, frequency of interaction with friends was indeed associated with survival, but only among the women.

Analysis of data from the Longitudinal Aging Study of Amsterdam revealed that respondents who reported having received a moderate or high level of emotional support had lower risks of mortality when compared with persons who received a low level of emotional support (Penninx et al. 1997). In contrast, receipt of a high level of instrumental support by respondents was related to a higher risk of death.

A study of Jewish-Israelis aged 75 and over attempted to disentangle the association of social network factors and mortality, controlling for demographic background and health behaviors (Walter-Ginzburg et al. 2002). However, the findings provided only partial clarification of the question at hand. The single network factor in the analysis to be associated with survival was group leisure activity, a measure of social engagement. One other purported network factor associated with mortality was residing with a child, but without a spouse. As the authors pointed out, this particular living arrangement may be a substitute for institutionalization and might actually be measuring functional state (Walter-Ginzburg et al. 2002). Thus, its direct relevance for understanding the social network–mortality association is limited.

A subsequent analysis of the same data set differentiated by gender yielded some additional insights (Walter-Ginzburg et al. 2005). The investigation showed that lower risk of mortality was associated with greater physical activity, with more frequent attendance at a synagogue, and with resilience in activities of daily living (ADL), among both men and women. Women's risk of mortality was also found to be reduced by reduction in smoking and by higher cognitive vitality. Men's risk of mortality, on the other hand, was found to be reduced by increased emotional support and more solitary leisure activity. These findings suggest some additional avenues by which social networks may impact mortality, but do not provide a singular explanation as to why.

Other predictors of mortality risk

Consideration of the social network–mortality association requires controlling for sociodemographic background variables known to be associated with greater propensity for death. The variables most associated with late life

mortality, in this regard, are age (Bath 2003), gender (Gustafsson et al. 1998; Pudaric et al. 2003) and socioeconomic status (Cooper et al. 2002; Manor et al. 1999). A study by Ahmad and Bath (2005) confirmed that age was the most relatively important predictor of mortality among elderly people who resided in the community.

Analysis of the effect of social network on mortality also requires taking into account the effects of psychobiological pathways that are associated with health outcomes that may lead to death. The Berkman model cites three such pathways. First, a health behavioral pathway includes health promotion and risk behaviors. Health promoting behavior, such as regular physical activity, is positively related to health and inversely related to mortality (Landi et al. 2004; Oida et al. 2003). Risk behaviors, on the other hand, are inversely related to health and positively associated with mortality. Smoking, for example, is known to decrease survival time (de Groot et al. 2004; Janssen and Kunst 2005).

A second pathway involves psychological factors such as emotional state as indicated, for example, by depression. Unlike as in the previous case, however, the literature on the effect of depression on mortality shows less uniform results. For instance, a meta-analysis by Cuijpers and Smit (2002) confirmed an increased risk of mortality in major depression and in sub-clinical forms of depression as well. However, a review by Wulsin et al. (1999) suggests that studies linking depression to early death may be poorly controlled. In Israel, Ben Ezra and Shmotkin (2006) found no association between depression and mortality, after controlling for self-rated health and other variables. On the other hand, Abas et al. (2002) did find that depression was associated with mortality in another setting, but only after controlling for gender.

A third psychobiological pathway in the Berkman model is the physiologic one, represented in the current analysis by the variable of morbidity. Morbidity, or major illness has been found to independently increase mortality risk in later-life, particularly cases of cancer, diabetes, heart attack and stroke (Feil et al. 2003; Schupf et al. 2005; van den Brink et al. 2005). Alzheimer disease has recently been recognized as an additional mortality risk factor of importance (Aguero-Torres et al. 1999; Tschanz et al. 2004).

In sum, the literature review shows that the components of the Berkman model are relevant to the study of the social network–mortality association. In addition, the paradigm presents a temporal dimension to our understanding of this association. That is, it clarifies the order in which network variables are seen to influence health outcomes. The analysis that is presented in the following pages utilizes this conceptual model as a means to identify the main social network factors that influence survival in later-life.

The context of the current analysis

A word is also required on the context of the current study. The inquiry examined the network correlates of 7-year all cause mortality in Israel. Veteran Jewish-Israelis constitute the majority segment of the Israeli cohort aged 70 and over (74%). Previous analysis has shown that the association of social network and health among veteran Jewish-Israelis differs from its association among other population groups, particularly Arab-Israelis and new immigrants from the Former Soviet Union (Litwin 2006). As such, the current inquiry focused upon veteran Jewish-Israelis only.

In addition, recent analysis has indicated that the association of network type and mortality in Israel differs for the 60–69 years age group (Litwin and Shiovitz-Ezra 2006). “Network type” is a composite measure that reflects a collection of key network variables (Fiori et al. 2006). In the recent analysis just noted, network type among respondents aged 70 and older was indeed associated with mortality, even after controlling for several other factors. But this was not the case among the young-olds, for whom mortality was explained primarily by gender, morbidity and disability. Accordingly, the current study focused upon respondents aged 70 and above.

Methods

The investigation utilized baseline data from a larger household survey of adults aged 60 and over that was carried out in 1997 by the Israeli Central Bureau of Statistics. The survey queried community-dwelling older adults and did not include persons who resided in institutional facilities. The overall survey sample encompassed some 5,055 individuals aged 60 and older, including 2,937 veteran-Jewish Israelis, 824 Arab-Israelis and 1,294 new immigrants from the Former Soviet Union.

As noted earlier, the current investigation focused on veteran Jewish-Israelis aged 70 and older only. Accordingly, the sub-sample for the analysis reported here numbered 1,811 respondents. A small number of them ($n = 79$) were interviewed by proxy, due to cognitive impairment or other disabilities. For the purpose of the present analysis, baseline survey data were linked to records from the National Death Registry, updated through 2004. The linkage showed that 684 veteran Jewish-Israelis aged 70 and older had died, constituting some 38% of the current study sample.

Study variables

The outcome variable was 7-year time to death. The baseline background framing variables in the analysis included:

age, income, education, gender and current work status. Age was considered at 5-year intervals, as follows: (1) 70–74 years old, (2) 75–79 years old, (3) 80–84 years old and (4) 85 years old and over. Income levels were divided into three: (1) low: up to \$10,000 per year (in New Israeli Shekels), (2) medium: up to \$20,000, and (3) high: over \$20,000 per year. Education was also measured at three levels: (1) low (from 0–4 years of primary school), (2) medium (5–12 years of schooling), and (3) high (more than 12 years). Gender and work status were noted as simple categorical variables (men = 1, women = 2; don't work = 0, work = 1).

Social network variables included respondents' marital status, the number of children residing in close geographic proximity, and frequency of contact with children, friends and neighbors. Marital status had three values (1 = married, 2 = widowed, and 3 = other unmarried). The number of proximate children was recoded into three levels: "none", "one or two", and "three or more". Contact frequency variables were generally recoded into three levels: "none", "low" and "high." For contact with children, an additional category of "no children" was included to control for childless individuals, a value of "low" was twice monthly contact or less, and a value of "high" was biweekly contact or more. For contact with friends and neighbors, "low" was once a week or less, and "high" was twice a week or more.

The psychosocial mechanism variables included two social support indicators and two social engagement measures. Support was addressed in terms of the exchange of instrumental and financial assistance. Baseline survey questions asked respondents whether they gave instrumental or financial assistance to their children and whether they were aided instrumentally or financially by them. The three response levels for instrumental assistance were: (1) don't help, (2) help occasionally (monthly or less) and (3) help frequently (weekly or more often). For financial assistance, the response levels were: (1) don't give, (2) rarely give, and (3) give from time to time, or regularly. Subtraction of the provision scores from the receipt scores allowed computation of two exchange variables—one instrumental and one financial. Each of the resultant exchange variables had four values: (1) receives more support than gives, (2) gives more support than receives, (3) equal exchange, and (4) no exchange.

The social engagement measures addressed included visitation at a senior club and synagogue attendance. Each was recoded into three values: "none", "low" and "high". For club visitation, "low" was once a week or less, and "high" was twice a week or more. As for synagogue attendance, "low" reflected attendance for events and holidays, and "high" indicated attendance once a week or more.

Psychobiological pathways were addressed in terms of health-promotion and/or risk behavior, emotional state and

physiologic pathways. Health-promotion and risk behavior were measured respectively by engagement in physical activities and by smoking. For the former, respondents were asked whether they had regularly engaged in any of the five physical activities—walking, jogging, exercise, swimming and bicycling, (usually weekly or more often). Their baseline answers were recoded into a single variable having three categories: "none", "one regular activity" and "two regular activities or more". Smoking at baseline was tapped by a simple yes (1) or no (0) response.

Emotional state was measured by means of a Hebrew version of the GHQ-12. In the current analysis, a cutoff point of 3/4 was adopted to determine caseness. That is, respondents who noted having had four or more depressive symptoms in the 6 months prior to baseline were considered to have been depressed. It should be noted that the 79 respondents in the current study sample interviewed by proxy were not given subjective questions, like the GHQ-12. In order to control for them, the summary GHQ scores were recoded according to three values, as follows: (0 = not depressed, 1 = depressed, 2 = proxy interview).

Finally, physiologic pathways were measured in terms of baseline morbidity. Respondents reported whether they had ever been diagnosed with cancer, heart attack, stroke, diabetes or Alzheimer disease. The morbidity indicator used in the analysis reflected three levels: (0 = no illness, 1 = one illness and 2 = two or more illnesses).

Analysis

The analysis was executed in two primary stages. First was a univariate examination of each of the study variables, along with analysis of the unadjusted association of each variable with mortality risk. Cox proportional hazards were employed for this purpose. Next was a hierarchical multivariate examination of the associations between study variables and mortality risk. Each variable block was entered successively, according to the order presented in the conceptual model. Here too, Cox hazards regressions were employed. The statistics presented in the multivariate analysis are the corrected risk ratios for each variable after controlling for the effects of each of the other variables in the analysis.

Results

Tables 1, 2, 3, 4 present the frequency distributions of the study variables and their bivariate associations with the mortality outcome. The frequency distributions appear in the first and second data columns of each table. The following paragraphs detail the unadjusted relative risks for mortality of each of the variables, as shown in the third and fourth data columns of each table.

Table 1 Background and mortality risk among older Israeli Jews: frequency distributions and unadjusted hazard ratios

Variables ^a	N	Percentage	Mortality risk		
			HR	95% CI	
Age group	70–74	605 33.3	1.00	–	–
	74–79	618 34.1	1.48 ***	1.19	1.85
	80–84	312 17.2	2.73***	2.17	3.44
	85+	276 15.2	4.64***	3.73	5.79
Income	Low	653 36.1	1.63***	1.32	2.02
	Medium	742 41.0	1.37**	1.11	1.70
	High	416 23.0	1.00	–	–
Education	Low	401 22.1	1.41**	1.11	1.78
	Medium	1,097 60.6	0.98	.80	1.21
	High	313 17.3	1.00	–	–
Gender	Women	861 47.5	1.00	–	–
	Men	950 52.5	1.40***	1.20	1.63
Work status	Not working	1,664 92.0	1.00	–	–
	Working	145 8.0	0.44***	0.30	0.64

^a Reference categories: age (70–74), income (high), education (high), gender (women), work status (not working)

** $P < 0.01$, *** $p < 0.001$

Unadjusted relative risks of mortality

Table 1 presents the relative risks of the background framing variables. The unadjusted hazard ratios indicate that the oldest group at baseline (85+) was almost five times more likely than the youngest age group (70–74) to be deceased 7 years later. Persons aged 80–84 were almost three times more likely to be deceased, and the 75–79 year old respondents had about a 50% greater chance of having died than respondents aged 70–74 at baseline.

Persons reporting the lowest income at baseline were about two-thirds more likely to have died than the high income group, and members of the middle income group were about a third more likely. Respondents with the lowest educational level, 4 years of schooling or less, were almost one-and-a-half times more likely to be deceased than the highest education group. However, the middle level of schooling did not have a greater mortality risk than those with the highest educational level.

As for gender, men had a 40% greater chance of having died than women. In terms of work status, respondents who still worked at baseline were more than twice as likely to have survived. In sum, all the background framing variables had significant unadjusted associations with mortality in the study population.

In contrast to the background variables, not all the social network variables revealed associations with mortality (Table 2). Most strongly associated at the bivariate level

was contact with friends. Respondents with no friends at baseline were more than twice as likely to have died 7 years later than respondents who had reported frequent contact with friends. There was no difference, on the other hand, between those with only some friend-contact and those with frequent contact. The same trend was evident regarding contact with neighbors, but to a more limited degree. Those with no neighbor-contact at baseline were almost 50% more likely to have deceased.

On the other hand, family ties were not clearly associated with the mortality outcome, for the most part. With regard to marital status, respondents who were widowed at baseline were a bit more than a third more likely to have died than those who had a living spouse. But persons who were unmarried for other reasons (never married, divorced, etc.) had no greater mortality risk.

As for relations with children, the figures in the table show that neither the number of proximate children nor frequency of contact was related to 7-year mortality. The first of these two variables was removed from the subsequent multivariate analysis. However, the frequency of contact variable was close to significance and, thus, was retained in the analysis.

Table 3 reports the relative risks of the psychosocial mechanism variables: social support, as measured by the exchange of instrumental and financial assistance, and social engagement at baseline. The unadjusted hazard ratios for the instrumental support exchange variable indicate that persons who had been mainly recipients at baseline had a 60% greater likelihood of having been deceased 7 years later, in comparison to persons who engaged in no exchange of instrumental support. This pattern gets reversed when viewing the results for financial support. Persons who were mainly recipients of financial support at baseline were about a third more likely to have survived than persons who engaged in no exchange of financial support. Those who gave more financial support than they received, on the other hand, had a greater likelihood of being deceased 7 years later, almost 40%.

As for the social engagement variables, the unadjusted hazard ratios show that respondents with frequent club attendance were indistinguishable from those who had never attended. Respondents who attended a senior club occasionally, on the other hand, were almost 60% more likely to have survived 7 years later. In comparison, persons with occasional synagogue attendance were indistinguishable from those who reported having frequently attended. However, those who never attended had a 60% greater likelihood of having died.

Table 4 presents the data on psychobiological pathway variables, all of which had significant hazard ratios at the bivariate level. Viewing the figures, one can see that respondents who did not engage in any physical activity at

Table 2 Social network and mortality risk among older Israeli Jews: frequency distributions and unadjusted hazard ratios

VARIABLES ^a		N	Percentage	Mortality risk		
				HR	95% CI	
Marital status	Married	992	54.8	1.00	–	–
	Widowed	708	39.1	1.38***	1.19	1.62
	Other unmarried	111	6.1	1.10	0.79	1.52
# proximate children	None	664	36.7	0.88	0.70	1.11
	1–2	872	48.2	1.04	.83	1.29
	3+	275	15.2	1.00	–	–
Contact with children	No children	94	5.2	1.19	0.87	1.64
	None	145	8.0	1.24	0.95	1.60
	Low	320	17.7	0.91	0.74	1.12
	High	1,252	69.1	1.00	–	–
Contact with friends	None	734	40.7	2.25***	1.87	2.70
	Low	460	25.5	1.09	0.87	1.36
	High	611	33.7	1.00	–	–
Contact with neighbors	None	855	47.2	1.49***	1.26	1.76
	Low	227	12.5	1.08	0.83	1.39
	High	726	40.1	1.00	–	–

^a Reference categories: marital status (married), # proximate children (3+), contact with children (high), contact with friends (high), contact with neighbors (high)

*** $P < 0.001$

Table 3 Psychosocial mechanisms and mortality risk among older Israeli Jews: frequency distributions and unadjusted hazard ratios

Variables ^a		N	Percentage	Mortality risk		
				HR	95% CI	
Instrumental support	Gets more	743	41.1	1.60***	1.37	1.89
	Gives more	78	4.3	0.71	0.45	1.13
	Equal	55	3.0	1.19	.77	1.86
	None	933	51.6	1.00	–	–
Financial support	Gets more	379	20.9	0.76**	0.62	0.93
	Gives more	232	12.8	1.38**	1.12	1.70
	Equal	16	0.9	1.50	0.78	2.90
	None	1,184	65.4	1.00	–	–
Club attendance	None	1,508	83.6	1.03	0.81	1.31
	Low	96	5.3	0.63*	0.40	0.99
	High	199	11.0	1.00	–	–
Synagogue attendance	None	715	39.7	1.60***	1.33	1.94
	Low	597	33.1	0.97	0.78	1.20
	High	489	27.2	1.00	–	–

^a Reference categories: instrumental support (none), financial support (none), club attendance (high), synagogue attendance (high)

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

all were almost three times more likely to have died than those who engaged in two or more such activities at baseline. Even people who engaged in one physical activity were more likely to be deceased (55%) than the most physically active group. The table also shows that smokers at baseline were a third more likely to have died than non-smokers.

Table 4 Psychobiological pathways and mortality risk among older Israeli Jews: frequency distributions and unadjusted hazard ratios

Variables ^a		N	Percentage	Mortality risk		
				HR	95% CI	
Physical activity	None	1,219	67.3	2.70***	1.93	3.78
	1	407	22.5	1.55*	1.07	2.25
	2+	185	10.2	1.00	–	–
Smoke	No	1,661	91.8	1.00	–	–
	Yes	148	8.2	1.35*	1.06	1.73
Depression	Not depressed	1,049	57.9	1.00	–	–
	Depressed	683	37.7	1.81***	1.55	2.12
	Proxy interview	79	4.4	5.49***	4.19	7.19
Morbidity	None	1,005	55.5	1.00	–	–
	1	588	32.5	1.54***	1.31	1.82
	2+	218	12.0	2.24***	1.82	2.76

^a Reference categories: physical activity (2+), smoke (no), depression (not depressed), morbidity (none)

* $P < 0.05$, *** $P < 0.001$

Turning to the emotional state indicator, it can be seen that persons who had been depressed at baseline were about 80% more likely to have died 7 years later than those who were not. The proxy interview control group, as expected, had a much greater risk of mortality, due to their already impaired state at baseline. The physiologic pathway indicator considered in this analysis—morbidity—also reflected significant relative mortality risk. Respondents who had one diagnosed major disease at baseline were 50% more likely to have died than those without major illness. Respondents with two or more such

illnesses were more than twice as likely to have been deceased, 7 years later.

Adjusted relative risks of mortality

In order to determine the relative effects of the study variables on mortality risk, a hierarchical multivariate survival analysis was performed. Variable blocks were entered into the regression in the order dictated by the Berkman analytic model: background framing variables, social network, psychosocial mechanisms and psychobiological pathways. The results of the multivariate analysis are summarized in Table 5. This final analysis was based upon 1,789 respondents. Twenty-two respondents were dropped from the procedure due to missing data on one or more variables. Of the dropped cases, 13 had died (59%). Thus, in the final analytic procedure there were 671 reported deaths (37.5%).

As may be seen in Model 1, the background variables of age and male gender maintained significantly higher risks of mortality when considered along with income and education. Active work status retained its significant association with survival. Viewing the background variables across each of the subsequent models, moreover, shows that these variables were consistent predictors of mortality. The effect of age and work status generally diminished somewhat in magnitude, but the gender effect tended to increase. Low educational level was also a predictor in model 1, but its effect disappeared in the subsequent models.

Model 2 shows the results of the addition of the social network variables to the analysis. The hazard ratios indicate that neither the marital relations variable nor the contact with children indicator was related to mortality. A lack of friendship ties, on the other hand, predicted greater mortality risk and a lack of neighbor ties approached significance. No difference was evident, however, in the extent of friend or neighbor contacts. Stated differently, the findings show that mortality risk in this variable block was increased mainly by the lack of social ties.

When psychosocial mechanism variables were added to the analysis in Model 3, the borderline effect of neighbor contacts disappeared, leaving the absence of friend contacts as the major interactional predictor of mortality. (Childless respondents achieved a mortality risk of borderline significance at this stage of the analysis). As may be seen, moreover, instrumental exchange obtained an association with mortality. Respondents who received more such assistance than they gave at baseline had about a third greater likelihood to have been deceased 7 years later. However, no other categories of instrumental exchange and none of the financial exchange measures were related to mortality.

Among the social engagement variables, attendance at a synagogue emerged as a major predictor. Compared to

those who reported frequent synagogue visits, respondents who did not visit the synagogue at all were three quarters more likely to have died seven years later, and people who visited the synagogue only occasionally were more than a third more likely to be deceased. No mortality risk was evident, on the other hand, in relation to club visitation.

The final model (Model 4) adds the psychobiological pathway variables through which, according to the Berkman paradigm, the previous variables work. As the model shows, all of the variables in the last block reflected a significant risk. Thus in terms of health behavior, smokers at baseline had a higher risk of 7-year mortality, as did those who engaged in no physical activity at all. However, those who engaged in only one physical activity did not have a greater mortality risk when compared to the even more physically active group. In addition, prior depression was associated with slightly greater mortality risk (as was proxy interview status, controlled in the current measure). Morbidity was also significantly associated with greater risk of mortality. Respondents with two or more major illnesses were twice as likely as those with no illness to have died 7 years after baseline, and those with one such illness were about 40% more likely to have deceased.

It is also important to note that the social network and psychosocial mechanism variables retained their predictive status in the final model, despite the addition of the psychobiological pathway measures. Absence of friendship ties ($HR = 1.47$), greater receipt of instrumental support than giving of such support ($HR = 1.27$) and lack of synagogue attendance ($HR = 1.61$) [as well as some synagogue attendance only ($HR = 1.41$)] remained significant predictors of death 7 years later. Moreover, the state of being childless emerged in the final model as an additional significant network predictor of mortality ($HR = 1.46$). These results and their significance for understanding the social network–mortality association are discussed in the next section.

Discussion

Using the Berkman conceptual model of the determinants of health as a paradigm for analysis of the social network–mortality association, this inquiry has identified a number of network-related components as predictors of survival (Berkman et al. 2000). Based upon a study of Jewish-Israelis aged 70 and over, the analysis found that contact with friends and synagogue attendance obtained significant hazard ratios with the mortality outcome, even after controlling for the other variables in the model. Lack of friendship ties in later-life and lack of attendance at a place of worship were related to greater mortality risk. Moreover, occasional attendance at a synagogue was also a risk factor when compared with frequent attendance.

Table 5 Hierarchical multivariate analysis of study variables and mortality: Adjusted hazard ratios (also continued on next page)

Variables ^a		Mortality risk					
		Model 1			Model 2		
		HR	95% CI		HR	95% CI	
Age	75–79	1.43***	1.14	1.78	1.44**	1.15	1.81
	80–84	2.57***	2.03	3.26	2.41***	1.90	3.07
	85+	4.25***	3.38	5.34	3.72***	2.94	4.72
Income	Low	1.14	0.91	1.44	0.92	0.72	1.18
	Medium	1.12	0.90	1.40	0.98	0.78	1.22
Education	Low	1.31*	1.02	1.67	1.17	0.91	1.51
	Medium	0.96	0.78	1.19	0.93	0.75	1.15
Gender	Men	1.54***	1.31	1.80	1.64***	1.39	1.93
Work status	Working	0.54**	0.37	0.80	0.56**	0.38	0.82
Marital status	Widowed				1.15	0.96	1.37
	other				1.00	0.70	1.43
Contact with children	No children				1.13	0.81	1.56
	No contact				1.08	0.81	1.43
Contact with friends	Low				0.87	0.70	1.07
	None				1.89***	1.55	2.30
Contact with neighbors	Low				1.18	0.94	1.49
	None				1.19+	1.00	1.41
Instrumental support	Low				0.95	0.73	1.23
	Gets more						
Financial support	Gives more						
	Equal						
Club attendance	Gets more						
	Gives more						
Synagogue attendance	Equal						
	None						
Physical activity	low						
	None						
Smoke	Low						
	1						
Depression	Depressed proxy						
Morbidity	1						
	2+						

Variables ^a		Mortality risk					
		Model 3			Model 4		
		HR	95% CI		HR	95% CI	
Age	75–79	1.41**	1.13	1.77	1.45**	1.16	1.82
	80–84	2.21***	1.74	2.82	2.15***	1.68	2.74
	85+	3.41***	2.67	4.35	3.54***	2.77	4.54
Income	Low	1.00	0.77	1.29	0.94	0.72	1.22
	Medium	1.07	0.85	1.35	1.00	0.80	1.27
Education	Low	1.25	0.96	1.62	1.15	0.88	1.51
	Medium	0.95	0.76	1.18	0.95	0.76	1.19

Table 5 continued

Variables ^a		Mortality risk					
		Model 3			Model 4		
		HR	95% CI		HR	95% CI	
Gender	Men	1.89***	1.59	2.24	1.79***	1.50	2.13
Work status	Working	0.57**	0.38	0.84	0.63*	0.42	0.93
Marital status	Widowed	1.12	0.93	1.33	1.15	0.96	1.38
	Other	0.94	0.65	1.34	1.03	0.72	1.48
Contact with children	No children	1.40+	0.98	2.00	1.46*	1.02	2.09
	No contact	1.29	0.94	1.75	1.20	0.88	1.64
Contact with friends	Low	0.92	0.74	1.15	0.97	0.78	1.21
	None	1.74***	1.42	2.14	1.47***	1.19	1.81
Contact with neighbors	Low	1.14	0.90	1.44	1.12	0.89	1.42
	None	1.14	0.95	1.36	1.08	0.90	1.28
Instrumental support	Low	0.88	0.68	1.15	0.89	0.68	1.16
	Gets more	1.31**	1.08	1.59	1.27**	1.05	1.55
	Gives more	0.97	0.60	1.56	1.02	0.63	1.64
Financial support	Equal	1.31	0.83	2.08	1.39	0.88	2.19
	Gets more	1.16	0.92	1.46	1.20	0.95	1.51
	Gives more	1.06	0.85	1.33	0.94	0.75	1.17
Club attendance	Equal	1.72	0.88	3.39	1.66	0.84	3.26
	None	1.01	0.78	1.29	1.09	0.84	1.41
Synagogue attendance	Low	0.74	0.46	1.17	0.79	0.49	1.26
	None	1.75***	1.42	2.15	1.61***	1.31	1.99
Physical activity	Low	1.38**	1.10	1.73	1.41**	1.12	1.76
	None				1.61**	1.12	2.31
Smoke	1				1.33	.91	1.95
					1.58***	1.22	2.04
Depression	Depressed proxy				1.24*	1.04	1.49
					2.31***	1.68	3.17
Morbidity	1				1.41***	1.19	1.68
	2+				1.89***	1.51	2.37

^a Reference categories: age (70–74), income (high), education (high), gender (women), work status (not working), marital status (married), contact with children (high), contact with friends (high), contact with neighbors (high), instrumental support (none), financial support (none), club attendance (high), synagogue attendance (high), physical activity (2+), smoke (no), depression (not depressed), morbidity (none)

+ 0.05 > P < .06, * P < 0.05, ** P < 0.01, *** P < 0.001

An additional network predictor found in the study was the exchange of instrumental support. However, since only greater receipt of such assistance was related to greater mortality risk, this finding must be viewed with some degree of caution. Finally, the state of being childless emerged as a predictor of mortality. But, the frequency of contact with children did not. These findings are discussed in light of the conceptual model.

First of note is the association between friendship ties and survival. Other recent studies have provided empirical verification of this finding (Giles et al. 2005; Maier and Klumb 2005; Rasulo et al. 2005). What is it about friendship ties that reduce mortality risk? The literature notes an association of friendship and health, suggesting that older people with friends are healthier, but also that healthier older people are more sociable. A Swedish study of persons aged 77 and older clarified that contacts with friends were related to well-being independently of earlier health status

(Lennartsson 1999). This implies that friendship mobilizes processes that may reduce mortality risk.

Another explanation is that as opposed to the prescribed nature of family and neighbor ties, friendship ties are the result of personal choice which reflects autonomy and control. Ford et al. (2000) maintain that attitudes favoring personal independence are associated with sustained autonomy in later life. Thus, the practice of choosing one's social ties (friends) could promote greater autonomy, which in turn, reduces mortality.

Data from the Longitudinal Aging Study of Amsterdam revealed that greater feelings of mastery were, indeed, associated with a reduced mortality risk when background and health characteristics were taken into account (Penninx et al. 1997). Correspondingly, a Canadian study showed that low levels of perceived internal control, personal commitment, and physical functioning were associated with mortality risk among older men, but not among older women (Fry and

Debats 2006). In contrast, Krause and Shaw (2000) found that feelings of control over life as a whole were not related to mortality among elderly study participants. Further inquiry of this issue is, thus, warranted.

The second major finding of note is the association between synagogue attendance and survival, supporting other studies that have found attendance at a place of worship to enhance survival in later life (Hill et al. 2005; la Cour et al. 2006). Church attendance is viewed in the Berkman model as a form of social engagement, one of the psychosocial mechanisms that are shaped by social network structure and interaction. Interestingly, the current inquiry showed that lack of contact with neighbors had greater mortality risk before the addition of the social engagement variables. The subsequent inclusion of synagogue attendance, however, weakened its effect. The explanation for this could be that neighbor ties and synagogue attendance both reflect the domain of community relations. Thus, the lack of belonging to a community, whether through neighbors or through a place of worship, is what increases the risk of mortality among elderly people (Berkman et al. 2000; Jaffe et al. 2005).

This explanation may not be enough to fully explicate the current findings, however. As noted, people who attended synagogue only on holidays and special events (the symbolic communal aspects of synagogue attendance) had greater mortality risk than persons who attended synagogue weekly or more often. This raises the possibility that it is the spirituality of synagogue attendance rather than its communality that enhances survival (Idler et al. 2003). Empirical research does not yet provide sufficient evidence for the existence of a spirituality–mortality association (Hummer et al. 2004; Pargament et al. 2001). However, a recent study did find support for the assertion that spirituality provides a protective effect against the neuroendocrine consequences of stress, thus lowering mortality risk (Tartaro et al. 2005).

A word is required as to the assignment of the variable of synagogue attendance to the realm of social engagement, a psychosocial mechanism in the Berkman model. Attendance at a place of worship has been recognized in earlier research as a key indicator of social network (interaction). However, if synagogue attendance indeed belongs conceptually to the psychosocial mechanisms that social networks activate, this would lend further support to the contribution of the sense of attachment to survival in later life.

The third finding to be discussed is the association found between instrumental exchange and mortality risk. As noted, respondents who received more such aid than they gave were seen, in this analysis, to have greater mortality risk. However, since no other instrumental exchange category was related to survival, including equal exchange, it seems that reciprocity of exchange is not the explanatory factor

behind the association. Rather, it could be that the greater receipt of instrumental aid reflects some other state, such as poor health, which in turn is associated with greater mortality risk. If so, the exchange of instrumental support is less a predictor of mortality than it is a precursor of poor health outcomes (Bisschop et al. 2003; Penninx et al. 1997).

As for relations with children, the analysis underscored the association of childlessness and mortality in later-life (Manor et al. 2000; Weltoff et al. 2004). But, frequency of contact with children was unrelated. It should be noted, in this regard, that family ties are the norm in Israeli society. Moreover, frequent contact with children may reflect both social contacts and caregiving tasks provided during illness. The latter case counterbalances a potential positive effect of family ties on survival. In addition, family ties may include negative exchanges that result in psychological distress (Newsom et al. 2005).

A few limitations of the current study must be noted as well. First, the operational definition of social support in the analysis was limited to instrumental and financial exchange. Penninx et al. (1997) have shown that emotional support is protective against mortality, but that instrumental support is not. Future analysis should take this into account.

Second, gender was included in the analysis, but extensive consideration of gender interactions was not. One such interaction was examined—the interaction of gender and synagogue attendance—but its effect was insignificant. Future analysis should give attention to other meaningful gender interactions which were beyond the scope of the current paper.

Third, although health was addressed in this study by means of morbidity, there is still the possibility that the association between network characteristics and mortality is somehow influenced by health (with poor health affording less opportunity for contact with friends and synagogue attendance and carrying a higher mortality risk; and good health affording more opportunity for contact with friends and synagogue attendance and carrying a lower mortality risk). This requires further examination.

Despite these limitations, the analysis reported in this article has clearly demonstrated that even after taking background framing forces and psychobiological pathways into account, selected social network variables retained significant associations with mortality. In particular, the study underscored the importance of friendship ties and communal attachment for survival in later life.

References

- Abas M, Hotopf M, Prince M (2002) Depression and mortality in a high-risk population: 11-year follow-up of the medical research council elderly hypertension trial. *Br J Psychiatry* 181:123–128

- Aguero-Torres H, Fratiglioni L, Guo Z, Viianen M, Winblad B (1999) Mortality from dementia in advanced age: a 5-year follow-up study of incident dementia cases. *J Clin Epidemiol* 52(8):737–743
- Ahmad R, Bath PA (2005) Identification of risk factors for 15-year mortality among community-dwelling older people using Cox regression and a genetic algorithm. *J Gerontol Med Sci* 60(8):1052–1058
- Bath PA (2003) Differences between older men and women in the self-rated health-mortality relationship. *Gerontologist* 43(3):387–395
- Ben-Ezra M, Shmotkin D (2006) Predictors of mortality in the old-old in Israel: the cross-sectional and longitudinal aging study. *J Am Geriatr Soc* 54(6):906–911
- Berkman LF, Syme SL (1979) Social networks, host resistance, and mortality: a nine-year follow up study of Alameda County residents. *Am J Epidemiol* 109:186–204
- Berkman LF, Glass T, Brissette I, Seeman TE (2000) From social integration to health: Durkheim in the new millennium. *Soc Sci Med* 51(6):843–857
- Bisschop MI, Kriegsman DMW, van Tilburg TG, Penninx B, van Eijk JTM, Deeg DJH (2003) The influence of differing social ties on decline in physical functioning among older people with and without chronic diseases: the longitudinal aging study, Amsterdam. *Aging Clin Exp Res* 15:164–173
- Cooper JK, Harris Y, McGready J (2002) Sadness predicts death in older people. *J Aging Health* 14(4):509–526
- Cuijpers P, Smit H (2002) Excess mortality in depression: a meta-analysis of community studies. *J Affect Disord* 72(3):227–236
- de Groot L, Verheijden MW, de Henauw S, Schroll M, van Staveren WA (2004) Lifestyle, nutritional status, health, and mortality in elderly people across Europe: a review of the longitudinal results of the SENECA study. *J Gerontol Med Sci* 59(12):1277–1284
- Feil D, Marmon T, Unutzer J (2003) Cognitive impairment, chronic medical illness, and risk of mortality in an elderly cohort. *Am J Geriatr Psychiatry* 11(5):551–560
- Flori KL, Antonucci TC, Cortina KS (2006) Social network typologies and mental health among older adults. *J Gerontol Psychol Sci* 61(1):P25–P32
- Ford AB, Haug MR, Stange KC, Gaines AD, Noelker LS, Jones PK (2000) Sustained personal autonomy: a measure of successful aging. *J Aging Health* 12(4):470–489
- Fry PS, Debats DL (2006) Sources of life strengths as predictors of late-life mortality and survivorship. *Int J Aging Hum Dev* 62(4):303–334
- Giles LC, Glonek GFV, Luszcz MA, Andrews GR (2005) Effect of social networks on 10 year survival in very old Australians: the Australian longitudinal study of aging. *J Epidemiol Community Health* 59:574–579
- Guilley E, Pin S, Spini D, d'Epinay CL, Herrmann F, Michel JP (2005) Association between social relationships and survival of Swiss octogenarians. A five-year prospective, population-based study. *Aging Clin Exp Res* 17(5):419–425
- Gustafsson TM, Isacson DGL, Thorslund M (1998) Mortality in elderly men and women in a Swedish municipality. *Age Ageing* 27(5):585–593
- Hill TD, Angel JL, Ellison CG, Angel RJ (2005) Religious attendance and mortality: An 8-year follow-up of older Mexican Americans. *J Gerontol Soc Sci* 60(2):S102–S109
- House JS, Robbins C, Metzner HL (1982) The association of social relationships and activities with mortality: prospective evidence from the Tecumseh community-health study. *Am J Epidemiol* 116(1):123–140
- Hummer RA, Ellison CG, Rogers RG, Moulton BE, Romero RR (2004) Religious involvement and adult mortality in the United States: review and perspective. *South Med J* 97(12):1223–1230
- Idler EL, Musick MA, Ellison CG, George LK, Krause N, Ory MG, Pargament KI, Powell LH, Underwood LG, Williams DR (2003) Measuring multiple dimensions of religion and spirituality for health research: conceptual background and findings from the 1998 general social survey. *Res Aging* 25(4):327–365
- Jaffe DH, Eisenbach Z, Neumark YD, Manor O (2005) Does living in a religiously affiliated neighborhood lower mortality? *Ann Epidemiol* 15(10):804–810
- Janssen F, Kunst AE (2005) Cohort patterns in mortality trends among the elderly in seven European countries, 1950–99. *Int J Epidemiol* 34(5):1149–1159
- Krause N, Shaw BA (2000) Role-specific feelings of control and mortality. *Psychol Aging* 15(4):617–626
- la Cour P, Avlund K, Schultz-Larsen K (2006) Religion and survival in a secular region. A twenty year follow-up of 734 Danish adults born in 1914. *Soc Sci Med* 62(1):157–164
- Landi F, Cesari M, Onder G, Lattanzio F, Gravina EM, Bernabei R (2004) Physical activity and mortality in frail, community-living elderly patients. *J Gerontol Med Sci* 59(8):833–837
- Lennartsson C (1999) Social ties and health among the very old in Sweden. *Res Aging* 21(5):657–681
- Litwin H (2006) Social networks and self-rated health: a cross-cultural examination among older Israelis. *J Aging Health* 18(3):335–358
- Litwin H, Shiovitz-Ezra S (2006) Network type and mortality risk in later life. *Gerontologist* 46(6):735–743
- Maier H, Klumb PL (2005) Social participation and survival at older ages: is the effect driven by activity content or context? *Eur J Ageing* 2(1):31–39
- Manor O, Eisenbach Z, Peritz E, Friedlander Y (1999) Mortality differentials among Israeli men. *Am J Public Health* 89(12):1807–1813
- Manor O, Eisenbach Z, Israeli A, Friedlander Y (2000) Mortality differentials among women: the Israel longitudinal mortality study. *Soc Sci Med* 51:1175–1178
- Newsom JT, Rook KS, Nishishiba M, Sorkin DH, Mahan TL (2005) Understanding the relative importance of positive and negative social exchanges: examining specific domains and appraisals. *J Gerontol Psychol Sci* 60(6):P304–P312
- Oida Y, Kitabatake Y, Nishijima Y, Nagamatsu T, Kohno H, Egawa K, Arao T (2003) Effects of a 5-year exercise-centered health-promoting programme on mortality and ADL impairment in the elderly. *Age Ageing* 32(6):585–592
- Orth-Gomer K, Johnson JV (1987) Social network interaction and mortality: a 6-year follow-up study of a random sample of the Swedish population. *J Chron Dis* 40(10):949–957
- Pargament KI, Koenig HG, Tarakeshwar N, Hahn J (2001) Religious struggle as a predictor of mortality among medically ill elderly patients: a 2-year longitudinal study. *Arch Intern Med* 161(15):1881–1885
- Penninx B, van Tilburg T, Kriegsman DMW, Deeg DJH, Boeke AJ, vanEijk JTM (1997) Effects of social support and personal coping resources on mortality in older age: the longitudinal aging study Amsterdam. *Am J Epidemiol* 146:510–519
- Pudarc S, Sundquist J, Johansson SE (2003) Country of birth, instrumental activities of daily living, self-rated health and mortality: a Swedish population-based survey of people aged 55–74. *Soc Sci Med* 56(12):2493–2503
- Rasulo D, Christensen K, Tomassini C (2005) The influence of social relations on mortality in later life: a study on elderly Danish twins. *Gerontologist* 45(5):601–608
- Rutledge T, Matthews K, Lui LY, Stone KL, Cauley JA (2003) Social networks and marital status predict mortality in older women: prospective evidence from the study of osteoporotic fractures (SOF). *Psychosom Med* 65(4):688–694
- Schupf N, Costa R, Luchsinger J, Tang MX, Lee JH, Mayeux R (2005) Relationship between plasma lipids and all-cause mortality in nondemented elderly. *J Am Geriatr Soc* 53(2):219–226
- Shahbasmeh S, Davies R, Wenger GC (1992) A longitudinal analysis of factors related to survival in old-age. *Gerontologist* 32(3):404–413

- Sugisawa H, Liang J, Liu X (1994) Social networks, social support and mortality among older-people In Japan. *J Gerontol* 49(1):S3–S13
- Tartaro J, Luecken LJ, Gunn HE (2005) Exploring heart and soul: effects of religiosity/spirituality and gender on blood pressure and cortisol stress responses. *J Health Psychol* 10(6):753–766
- Tschanz JT, Corcoran C, Skoog I, Khachaturian AS, Herrick J, Hayden KM et al (2004) Dementia: the leading predictor of death in a defined elderly population—The Cache County study. *Neurology* 62(7):1156–1162
- van den Brink CL, Tijhuis M, van den Bos GAM, Giampaoli S, Nissinen A, Kromhout D (2005) The contribution of self-rated health and depressive symptoms to disability severity as a predictor of 10-year mortality in European elderly men. *Am J Pub Health* 95(11):2029–2034
- Walter-Ginzburg A, Blumstein T, Chetrit A, Modan B (2002) Social factors and mortality in the old-old in Israel: The CALAS study. *J Gerontol Soc Sci* 57(5):S308–S318
- Walter-Ginzburg A, Shmotkin D, Blumstein T, Shorek A (2005) A gender-based dynamic multidimensional longitudinal analysis of resilience and mortality in the old-old in Israel: the cross-sectional and longitudinal aging study (CALAS). *Soc Sci Med* 60(8):1705–1715
- Weltoft GR, Burstrom B, Rosen W (2004) Premature mortality among lone fathers and childless men. *Soc Sci Med* 59:1449–59
- Wen M, Cagney KA, Christakis NA (2005) Effect of specific aspects of community social environment on the mortality of individuals diagnosed with serious illness. *Soc Sci Med* 61(6):1119–1134
- Wulsin LR, Vaillant GE, Wells VE (1999) A systematic review of the mortality of depression. *Psychosom Med* 61(1):6–17
- Yasuda N, Zimmerman SI, Hawkes W, Fredman L, Hebel JR, Magaziner J (1997) Relation of social network characteristics to 5-year mortality among young-old versus old-old white women in an urban community. *Am J Epidemiol* 145(6):516–523