

Social Support and Risk-Adjusted Mortality in a Frail Older Population

Helena Temkin-Greener, PhD, Alina Bajorska, MS,* Derick R. Peterson, PhD,†
Stephen J. Kunitz, MD, PhD,* Diane Gross, PhD,* T. Franklin Williams, MD‡,
and Dana B. Mukamel, PhD§*

Objective: The objective of this study was to test the hypothesis that social support is an important predictor of mortality in a frail older population receiving formal long-term care services.

Research Design and Methods: The analysis is based on 3138 individuals enrolled in 28 Programs of All-Inclusive Care for the Elderly (PACE). Information about the enrollees is obtained from dataPACE. Semiparametric Cox proportional hazards models are estimated to assess the importance of individual risk factors, program effect, and social support.

Results: The introduction of the social support variables into the mortality model containing the sociodemographic, health needs, and the PACE-site indicator variables results in a significant improvement of the overall model fit. Several social support variables are statistically significant predictors of mortality. Controlling for all participant and caregiver characteristics, participants whose caregiver is a spouse have a significantly lower risk of mortality (hazard ratio = 0.63) compared with those whose caregiver is not a spouse. Furthermore, caregivers' assistance with meals confers a significantly lower risk of mortality (hazard ratio = 0.66) compared with no assistance with meals.

Conclusions: This study shows that certain aspects of informal caregiving are important factors enhancing survival in a population of frail, nursing home-certifiable individuals enrolled in a health program that already provides extensive services, including personal care, chores, and meals. Further research to better differentiate between the affective versus the instrumental dimensions of social support is needed to guide programs on how to balance the use of

resources to provide both the necessary formal services and the support for the informal caregivers.

Key Words: survival, risk-adjusted mortality, social support, informal caregivers, PACE

(*Med Care* 2004;42: 779–788)

The literature on the relationship among health, mortality, and social support is very rich but not unambiguous.¹ Social support has been variously defined as the existence, functional content, quantity, and/or quality of social relationships with family, friends, and even formal social institutions.² Although some studies find no relationship between social integration or isolation and mortality,^{3–6} others suggest that social relations could result in poorer health or increased mortality risks.^{4,7,8} On the other hand, numerous studies have shown that when social support is high, the risk of mortality is reduced after controlling for various measures of health status and demographic characteristics.^{2,9–15} Large epidemiologic studies suggest that lack of social support constitutes a major risk factor for mortality with statistical effect sizes comparable to such health risk factors as high blood pressure, smoking, or obesity.¹⁶ For example, Boulton reports that the lack of social contacts among older individuals results in a 2.3-fold increase in the risk of death over a 4-year period.¹³ A national study of the elderly in Japan documents a 1.5-fold increased risk of mortality among those with no social participation.¹² Greater social participation is also associated with improved survival in patients with coronary artery diseases.^{17,18}

The mechanisms through which social support is associated with mortality are also not well understood. Social support could affect health and mortality through physiological and/or behavioral pathways.¹⁹ Studies in psychoneuroimmunology have suggested that negative emotions and stressful experiences stimulate the production of proinflammatory cytokines contributing to prolonged infection and delayed wound healing.^{20,21} Studies focusing on behavioral pathways

From the *Departments of Community and Preventive Medicine and †Biostatistics, and the ‡Department of Medicine, Monroe Community Hospital, University of Rochester School of Medicine, Rochester, New York; and the §Department of Medicine, Division of Internal General Medicine & Primary Care, Health Policy Research, University of California, Irvine, California.

This study was supported with funding from the National Institute on Aging Grant R01-AG17555.

Reprints: Helena Temkin-Greener, PhD, Department of Community and Preventive Medicine, University of Rochester, School of Medicine, Box 644, 601 Elmwood Avenue, Rochester, NY 14642. E-mail: Helena_Greener@urmc.rochester.edu.

Copyright © 2004 by Lippincott Williams & Wilkins

ISSN: 0025-7079/04/4208-0779

DOI: 10.1097/01.mlr.0000132397.49094.b3

have established the lack of support as a risk factor for mortality, although the mechanisms and processes linking social support to health and mortality have not been clearly elucidated.^{9,12}

Although these studies have made some strides in clarifying the association and the possible pathways between social support and mortality, a number of challenges remain. Most importantly, many studies have been unable to adequately control for access to formal health services. Without knowing what is the extent of access to formal services, it is difficult to ascertain whether informal support is a substitute for needed formal care and thus to distinguish between its instrumental and emotional aspects. Furthermore, most studies include a wide range of individuals from the fairly healthy to the very frail. Because sickness has been shown to both reduce social participation and to elicit more social support,^{22,23} comingling of these populations could produce a spurious association between social support and mortality, particularly if health status is insufficiently controlled.

The Program of All-Inclusive Care for the Elderly (PACE) offers a unique model within which to examine the hypothesis that social support, independently of access to care, contributes to survival. First, all program enrollees receive a full spectrum of services from preventive to primary, acute, rehabilitative, and long-term care.^{24,25} Second, all enrollees are very frail and disabled and meet the eligibility criteria for nursing home care within their state of residence.²⁵ Finally, notwithstanding the availability of formal healthcare services, PACE enrollees have been shown to have high rates of informal support.²⁶

In this study, we examine the risk of mortality and its association with informal social support among the enrollees of 28 PACE plans around the country.

Modeling Social Support

The term social support refers to different aspects of social relationships. In this study, following the conceptual framework presented by House et al.,²⁷ we differentiate 3 domains. These domains—availability, source, and content/quantity—are logically and empirically interrelated. The *availability* or existence of social relationships is a necessary precondition for social support. The structure of a person's social relationships will determine the *sources* of support, ie, spouses, children, other relatives, and so on. The sources of support, as well as the nature of the problem requiring support, impact the functional *content* and the *quantity* of support provided. This could range from affective and emotional support to instrumental or tangible aid that could include such activities as providing assistance with household tasks, transportation, or financial assistance.²⁸ The provision of such tangible assistance has been hypothesized as being synonymous with better care that could influence health and mortality independently of professional medical services.²⁹

In their landmark study, House et al.⁹ suggested that social support affects mortality through moderating health behaviors. In the context of PACE, moderating of health behaviors could be expressed in several ways. Attention of an informal caregiver could prompt quicker intervention and access to needed health services. Social support can also be seen as outright providing the care that could be needed, but might not be accessible or available through the formal healthcare system. Although PACE participants have access to a comprehensive healthcare benefit package, including personal care, meals, and help with activities of daily living, the amount of services actually provided varies both within and between programs. Informal care could augment formal care, perhaps to the benefit of the individuals receiving it. Social support could also facilitate health-promoting behaviors such as sleep, proper nutrition, or adherence to medical regimen. Although the PACE benefit package includes the provision of meals and the management of medications, as needed, attention of the informal caregivers could improve nutrition and dietary habits as well as adherence to a prescribed medication regimen.

For each domain of social support defined in the conceptual framework, we hypothesize the following:

- The *availability* of an informal caregiver is an important factor in predicting survival in PACE.
- We hypothesize that different *sources* of social support could have different impacts on mortality. For example, spouse caregivers could be most important because they are more likely to provide both instrumental and affective support compared with other caregivers.
- We also hypothesize that the *content* of social support provided could impact survival. For example, caregivers' assistance with meals could have a greater impact on survival of PACE participants than other supportive services, which the program also provides. Informal caregivers are more likely to know the culinary tastes of their care recipients, thus preparing meals that are more appealing and likely to be consumed. Furthermore, the social interaction that could accompany a meal provided by an informal caregiver is likely to be substantially more important than simply the caloric content of a home-delivered meal provided by the program. The *quantity* of social support received could also be an important predictor of survival, particularly for those who do not coreside with their caregiver and who are more likely to receive intermittent informal support. Furthermore, the caregiver's age could modify both the content and the quantity of social support provided. Caregivers who themselves are older could be less likely to provide the same types or levels of social support as those who are younger. Similarly, employed caregivers, or those who do not coreside with the care recipient, might not be in a position to provide as much

support as those who are not employed or those who live with the care recipient.

DATA AND METHODS

Sample

This study is based on 28 of the 33 PACE programs in existence before December 1999. The study included new enrollees admitted to PACE between January 1, 1998, and December 31, 1999. Excluded were those whose health and functional assessment data were missing ($n = 278$); who enrolled, left, and reentered the program during this time ($n = 100$); whose data indicated chemotherapy without a diagnosis of cancer ($n = 14$); and those whose record contained more than 3 missing values ($n = 156$). In records with fewer than 3 missing values, these were imputed based on site-specific means. Most baseline health status assessments in PACE occur within the first month of enrollment in the program. However, in some cases ($n = 320$), health status assessments were not completed until the end of the second month after enrollment or even later. Because in this study, individual risk-adjustment is based on characteristics at enrollment in PACE, we also excluded those participants from the analysis. The final sample for the mortality model includes 3138 participants. There were 430 deaths and 2708 censored cases in the sample.

The group-excluded, as a result of the lack of baseline (within the first 31 days after enrollment) assessment data, represents a substantial portion of our sample and could potentially bias the results. Therefore, we reestimated the final hazards model on the larger sample ($n = 3458$) that included those with later initial health assessments. We found no significant differences between this model and the 1 done on the final sample of 3138 participants whose results we present in the article.

Data

We obtained information about each enrollee from DataPACE—a person-specific administrative database, which contains information about the participants' sociodemographics, informal caregiver support, health status and disability, medical history, service utilization, and date of death. Information is recorded at specific intervals several times per year and is produced by several sources, including self-reports (eg, self-assessed health status); interviews conducted by social workers (eg, informal caregiver support); PACE intake workers (eg, sociodemographics); program physicians and nurses (eg, clinical assessment of functional and cognitive status); and service use data (eg, day-center visits, hospital and nursing home admissions). Assessments of dataPACE quality have been reported elsewhere.^{30,31}

Factors Influencing Mortality

As discussed earlier, 3 domains of social support are included in this model, each defined by several variables. The *availability* of social relationships is defined as the presence or absence of an informal caregiver. The *source* of social support is defined by the relationship between care recipient and caregiver (eg, spouse, child, a relative) and by caregiver characteristics that can further modify the content of support provided (eg, age of caregiver, coresidence, employment status). We define the *content* of social support by the type of supportive acts performed (eg, personal care, medication and money management, transportation, meals, and chores). The *quantity* of support provided is measured directly (as hours per week), but only for those caregivers who do not coreside with the care recipient.

In addition to social support, a number of factors are known to have a direct effect on mortality. These include sociodemographic characteristics, physical and cognitive health, and access to formal health services. An extensive literature review and several sessions with clinical experts served as a guide in selecting personal characteristics that are likely to influence mortality. Because these factors could confound the association between social support and mortality, we included them in the models we estimated.

In the final model presented in this article, 4 measures of sociodemographic characteristics are included. These are age, gender, ethnicity/race, and education. Additionally, 12 measures of health status are also included. These are self-reported health status; inability to toilet or walk without assistance; inability to perform all 8 instrumental activities of daily living (IADLs; housework, heavy chores, money management, meal preparation, medication-taking, shopping, laundry, and transportation); cognitive status scored according to the Short Portable Mental Status Questionnaire (SPMSQ);³² daily use of oxygen; wandering behavior; and selected medical conditions—cancer (with and without chemotherapy), diabetes, renal failure, and chronic obstructive pulmonary disease (COPD). All of these person-specific characteristics are obtained from the initial health assessment.

We also include in the final model the site variable indicating the PACE program where the participant is enrolled. This allows us to control for the effect of the site and the potential variations across sites in medical care practices and the provision of formal care. We recognize, however, that even within a program, not all patients receive the same amount and type of formal support. Therefore, we tested for the possible substitution of informal support for unmet formal service needs. In 1 of the preliminary models, we included those formal services that informal support could substitute or complement, ie, hours of formal personal care or chores at home, day-center attendance days, and the number of home delivered meals. These variables were not statistically signif-

icant. As such variables are likely to be highly colinear, we tested for their joint significance with an F test. Finding none, we do not include these variables in our final model.

Statistical Analyses

We estimated semiparametric Cox proportional hazards models, assuming a common nonparametric baseline hazard function.³³ The outcome variable was the time to death from enrollment in PACE. Survival time was defined as the time between enrollment in PACE and death or the end of the study period on December 31, 1999, at which point surviving participants were censored.

Ordered categorical variables were redefined as dichotomous for each category (eg, self-assessed health = poor—yes = 1, no = 0) to allow for nonlinear associations with the outcome. When the effect of adjacent categories (eg, excellent, good, and fair self-assessed health) were not statistically different, they were collapsed into 1 category without significantly worsening the fit of the model as measured by the likelihood ratio χ^2 test.

Standard large-sample approximations to the distributions of the log hazard ratios were used to construct 95% confidence intervals for the hazard ratios and to perform 2-tailed hypothesis tests at the significance level of 0.05. To assess the relative importance of each group of predictors (sociodemographic, health status, social support, and PACE site indicator), nested models were fit and their partial likelihoods (or, equivalently, their model χ^2 statistics) were compared, both using the likelihood ratio test (to obtain P values) and by comparing the proportion of entropy explained by each successively added group of variables relative to the largest (maximum entropy) model.³⁴ This allows us to examine the impact of suppressing the effects of the more distal mortality risk factors (eg, such characteristics as enrollment in a given PACE program or the impact of social support) when the more proximal mortality risks (eg, sociodemographics or health status characteristics) are entered first into the model. To some extent, the sequence by which these groupings of characteristics are entered into the equation is arbitrary and could affect the proportion of entropy each grouping independently explains. Because we introduce social support as the last group, we could be under- rather than overestimating its impact on mortality. This is a conservative approach, likely to introduce a bias in favor of the null hypothesis that social support does not influence mortality.

RESULTS

Characteristics of the Sample

In Table 1, we present descriptive statistics by PACE site. The average PACE enrollee included in our study is a 78.6-year-old woman (73%) with 6.8 medical conditions, 4.0 ADL limitations, and a frequent diagnosis of dementia (51%).

Approximately half (47%) of the participants are white, with substantial program-by-program variation.

In Table 2, we present mean values for the dependent (time to death) and all of the independent variables initially included in the analyses. Through successive preliminary models, we eliminated those variables, which based on the Wald test, had P values greater than 0.2. To ascertain the appropriateness of excluding these variables, we performed the likelihood ratio tests for each deleted group. The P value of the likelihood ratio test for the whole group of eliminated variables was 0.95.

Seventy-two percent of the participants had an informal caregiver. The informal caregivers are as likely (32.2%) as not (35.3%) to live in the same household as the participant, and in 32.4% of the cases, both household and nonhousehold caregivers are identified. The informal caregivers are mostly the participants' children or children-in-law (55.3%), spouse (17.4%), or other relatives (17.9%). Social support provided by nonrelatives is limited to fewer than 10% of the participants. The informal caregivers report providing support with personal care (57.2%), meals (78.3%), chores (92.8%), money management (82.7%), medication management (68.1%), and transportation (81.1%). On average, the nonhousehold caregivers report devoting 9.5 hours per week (standard deviation, 16.3) in providing these instrumental supports.

Relationships Among Explanatory Variables and Mortality

Effect of Caregivers on Mortality Hazard

The final estimated survival model is shown in Table 3. Both participant-specific characteristics and PACE-site indicator variables are included in the model. Patient characteristics that are statistically significant at $P < 0.05$ -level are noted in the table. A positive coefficient indicates that higher values of the corresponding variable are associated with increased hazard (risk) of mortality.

Program participants for whom information on informal caregivers is not available are at a significantly ($P = 0.01$) greater risk (hazard ratio [HR] = 1.77) of dying than those with or without caregiver support. Based on personal communication with program administrators, such participants tend to be cognitively impaired and have a court-appointed public guardian.

Controlling for all participant and caregiver characteristics, participants whose caregiver is a spouse have a significantly ($P = 0.01$) lower risk of mortality (HR = 0.63) compared with those whose caregiver is not a spouse. It is interesting to note that gender of a spouse-caregiver does not make a difference. In a model (not shown) that included interactions between spouse-caregiver and spouse's gender, the interaction was not statistically significant ($P = 0.40$).

Of the 4 types of informal care support included in the final model, only 1 appears to be significantly related to

TABLE 1. Descriptive Statistics by PACE Site: Population Enrolled January 1, 1998–December 1, 1999

PACE Program*	No. New Enrollees 1/1/98–12/1/99	Average Age	Percent Female	Percent White	Percent Caregiver Support	Average No. ADLs	Average No. Medical Conditions	Percent With Dementia
All Sites	3138 [†]	78.6	73	47	72	4.0	6.8	51
East Boston, MA	173	80.1	77	89	85	3.5	7.6	43
Dorchester, MA	42	76.8	69	21	33	4.2	6.8	52
Worcester, MA	116	80.5	84	96	94	4.8	5.7	66
Cambridge, MA	74	79.5	72	73	61	4.0	5.8	53
Lynn, MA	210	75.7	67	77	83	3.4	6.4	27
Portland, OR	73	78.8	74	93	81	3.2	8.2	42
Columbia, SC	222	78.1	76	27	96	4.8	6.6	74
Milwaukee, WI	185	77.8	77	47	79	3.0	8.1	47
Madison, WI	38	77.9	92	71	45	3.0	7.9	16
Schenectady, NY	68	77.6	73	96	91	4.3	7.2	29
Rochester, NY	177	78.7	59	72	93	5.2	8.1	42
Syracuse, NY	39	81.7	85	87	74	3.7	9.2	38
Chicago, IL	68	75.1	65	4	85	2.5	6.2	26
El Paso, TX	97	78.4	63	1	91	4.1	7.4	70
Denver, CO	196	80.6	69	60	58	3.7	6.2	78
Honolulu, HI	48	80.1	75	4	96	4.2	6.9	46
Chattanooga, TN	106	78.1	75	40	94	4.9	4.6	54
Seattle, WA	72	77.5	68	65	42	5.3	6.8	51
Cleveland, OH	98	77.5	87	13	49	5.1	9.8	61
Cincinnati, OH	46	78.4	80	30	33	3.3	5.2	67
Albuquerque, NM	161	80.3	74	46	98	3.0	7.4	54
Baltimore, MD	74	78.2	86	57	78	3.2	7.7	62
Detroit, MI	112	81.0	94	4	90	2.8	8.1	56
Norfolk, VA	84	77.4	75	15	37	6.1	4.1	51
Los Angeles, CA	75	77.6	73	8	75	4.2	5.1	47
Sacramento, CA	12	77.6	71	58	66	3.9	6.4	41
Oakland, CA	124	76.1	59	13	48	3.5	6.2	43
San Francisco, CA	240	80.2	71	17	‡	3.9	5.8	41

*Some programs start with dual (Medicare and Medicaid) capitation in place, whereas others begin with Medicaid and then move to Medicare capitation.
[†]Includes all new admissions, except 320 for whom health assessment was not available on admission.
[‡]Data on informal caregiver support were available only for part of the study period for this site. The percent caregiver support would not represent the true figure for the site.
 PACE indicates Programs of All-Inclusive Care for the Elderly; ADLs, activities of daily living.

mortality: assistance with meals. Caregivers' assistance with meals confers a significantly ($P = 0.01$) lower risk of mortality (HR = 0.66) compared with no assistance with meals.

Effect of Other Individual Risk Factors on Mortality Hazard

Consistent with other studies, sociodemographic variables such as older age and male gender are positively and statistically significantly predictive of mortality in PACE. We observe significant ($P = 0.01$) mortality differentials between whites (and Asians) and Hispanics (HR = 0.60), as well as blacks (HR = 0.64). This black

advantage has been reported in other studies,^{35,36} although the Hispanic advantage has not.

Among the health need variables, only the following are significant risk factors for mortality: poor self-assessed health, inability to toilet independently, limitations in walking, impaired cognition, oxygen dependence, and the diagnoses of cancer, diabetes, or renal failure.

Substantial variations also exist in the effect of PACE-site indicator on mortality (Appendix 1). The PACE-site indicator could reflect differences in practice styles, organizational structure, process of care, and so on. Detailed analysis of this variation is beyond the scope of this article.

TABLE 2. Descriptive Statistics of Variables Included in the Analysis

Variables	Category/Level	Mean (standard deviation)	
Outcome = survival	time to death (months)	10.5 (6.5)	
Independent Variables			
Sociodemographic			
Age	Years	78.6 (9.4)	
Gender	Male	27.0%	
Ethnicity	White	46.7%	
	Hispanic	14.8%	
	Black	31.0%	
	Asian	6.5%	
	Other	1.1%	
Education	Years	8.7 (4.2)	
Living arrangement	Alone	33.2%	
	With spouse	13.3%	
	In nursing home	2.0%	
	All other	51.6%	
Social Support			
Informal caregiving*	No data	16.2%	
	Caregiver identified	71.9%	
	Nonhousehold only	35.3%	
	Household only	32.3%	
	Both	32.4%	
Relationship of informal caregiver to participant	Spouse	17.4%	
	Child	55.3%	
	Other relative	17.9%	
	Nonrelative	9.4%	
	Employed	51.6%	
Caregiver's employment	Years	54.6 (14.9)	
Age of primary caregiver	Years	54.6 (14.9)	
Type of caregiver support provided	Personal care	57.2%	
	Meals	78.3%	
	Chores	92.8%	
	Money management	82.7%	
	Medications	68.1%	
	Transportation	81.1%	
	Hours of support per week	9.5 (16.3)	
	Site indicator variable		
Intensity of support by nonhousehold caregiver	Hours of support per week	9.5 (16.3)	
PACE program	Site indicator variable		
INDEPENDENT VARIABLES			
Health Needs			
Source of referral to the program	Hospital	8.7%	
	Nursing home	4.1%	
	Home care agency	11.9%	
	Social services	29.4%	
	Physician	7.0%	
	Other	38.9%	
	ADL—bathing		82.9%
	ADL—dressing		68.3%
ADL—grooming		71.7%	
ADL—toileting		47.9%	
ADL—transfer		44.8%	
ADL—walking		50.5%	
ADL—feeding		29.1%	
IADL <8		31.6%	
IADL >8		68.4%	
>8 Errors in SPMSQ		14.8%	
Bladder incontinence		58.8%	
Bowel incontinence		27.6%	
Cancer without chemotherapy		10.4%	
Cancer with chemotherapy		0.4%	
Congestive heart failure		19.3%	
Other heart disease		47.1%	

(continued next page)

Variables	Category/Level	Mean (standard deviation)
Respiratory disease		8.5%
Cerebrovascular disease		29.1%
Infections		3.3%
Dementia		50.5%
Depression		32.5%
Hypertension		59.2%
Chronic obstructive pulmonary disease		13.3%
Diabetes		32.1%
Renal failure		7.5%
Parenteral medications		10.4%
Daily oxygen		4.9%
Dialysis		1.3%
Wandering behavior		12.5%
Verbally aggressive behavior		9.8%
Physically aggressive behavior		5.7%
Regressive behavior		8.0%
Self-assessed health	Poor	11.9%
	Fair-to-excellent	74.4%
<i>Health Utilization</i>	Average monthly	
	Hours personal care or chores	30.0 (36.2)
	Days in the day center	9.2 (5.9)
	Home-delivered meals	15.7 (12.3)

*Characteristics of informal caregivers are calculated for a subset of population with caregivers.

PACE indicates Programs of All-Inclusive Care for the Elderly; ADL, activity of daily living; IADL, instrumental activity of daily living; SPMSQ, Short Portable Mental Status Questionnaire.

Contribution of Social Support to the Explanation of Mortality Hazard

Table 4 presents the contribution of sociodemographics, health needs, PACE-site indicator, and social support variables to explanation of mortality hazard (incremental-explained entropy). The first column shows the results when only the sociodemographic characteristics are entered into the model. This model is a significant improvement ($\chi^2 = 67.67$; $df = 6$; $P < 0.0001$) over the null or the empty model, and it accounts for 19.7% of the total model fit. The health-need variables are also significantly predictive of the mortality risk ($\chi^2 = 190.47$; $df = 12$; $P < 0.0001$), and account for 55.5% of the total model fit. Column 3 shows the results of introducing the variable indicating the PACE sites where the participants are enrolled. The introduction of this variable explains 17.5% of the model fit and also represents a significant model improvement ($\chi^2 = 60.03$; $df = 14$; $P < 0.0001$). Finally, introducing the social support variables significantly improves the overall model ($\chi^2 = 25.02$; $df = 8$; $P < 0.0015$) and accounts for the remaining 7.3% of the total model fit.

DISCUSSION

The purpose of this study was to test the hypothesis that social support is an important predictor of risk-adjusted mortality in PACE, a program that provides formal long-term care to its participants. Our results are generally consistent with many prior studies documenting a protective effect of

social support vis-à-vis mortality. The introduction of the social support variables into the mortality model already containing the sociodemographic, health needs, and the PACE-site indicator variables accounts for the remaining 7% of the total model fit and results in a significant improvement of the overall model fit. What makes our results particularly interesting is that we observe this protective effect in a population composed of very frail and disabled individuals who receive a very rich and comprehensive health benefit package from their health plans.

Reduced risk of mortality associated with social support has been consistently demonstrated before. Most studies assumed that what is important about social relationships is their instrumental or supportive quality and the capacity to buffer the deleterious effects of health hazards. What makes our results novel is that we find these effects of social support in a program like PACE where most instrumental support is provided by the program itself. Although we cannot separately measure the effect of affective versus instrumental social support, our findings suggest that, at least to some extent, the observed impact on mortality could be more likely attributable to the affective rather than the instrumental or moderating qualities of social support, because only a spouse-caregiver has a protective effect, whereas other caregiving relationships do not. Because most spouse-caregivers are themselves older and often not in the best of health, the extent of instrumental support they provide is probably not extensive, especially compared with other caregivers with

TABLE 3. Mortality—Proportional Hazards Model: Impact of Personal Characteristics, Controlling for Site*

Predictor Variables		Parameter Estimate	P Value <0.05	95% HR CI Limits	Hazard Ratio
Sociodemographics					
Age	Years	0.0232	0.00	1.011–1.036	1.02
Male Gender		0.4282	0.00	1.234–1.908	1.53
Ethnicity	White (Asian and other) [†]				
	Black	–0.4518	0.00	0.485–0.835	0.64
	Hispanic	–0.5102	0.01	0.419–0.860	0.60
Education	Years	0.1099	0.01	1.025–1.216	1.12
Education sq	Years squared	–0.0056	0.03	0.990–0.999	0.99
Social Support					
Presence of any informal caregiver	No caregiver [†]				
	No information	0.5734	0.00	1.156–2.724	1.77
	Caregiver present	–0.2135	NS	0.453–1.440	0.81
Relationship of caregiver	Other [†]				
	Spouse	–0.4555	0.01	0.434–0.926	0.63
Age of caregiver		0.0119	0.01	1.002–1.022	1.01
Type of informal support provided	Meals	–0.4164	0.01	0.474–0.918	0.66
	Chores	0.4069	NS	0.898–2.514	1.50
	Medication management	0.3016	NS	0.986–1.854	1.35
	Transportation	0.2521	NS	0.945–1.751	1.29
Health Needs					
Self-reported health	Poor (and not recorded) [†]				
	Fair-to-excellent	–0.2882	0.01	0.598–0.940	0.75
ADL—toileting		0.3437	0.01	1.087–1.829	1.41
ADL—walking		0.4137	0.00	1.177–1.944	1.51
No. IADLs = 8		0.0755	NS	0.958–1.214	1.08
>8 errors in SPMSQ		0.3305	0.02	1.063–1.822	1.39
Cancer without chemotherapy		0.6508	<0.00	1.488–2.471	1.92
Cancer with chemotherapy		2.8008	<0.00	7.808–34.690	16.46
Dx—COPD		0.2732	NS	1.004–1.719	1.31
Dx—diabetes		0.2762	0.01	1.068–1.627	1.32
Dx—renal failure		0.5283	0.00	1.255–2.291	1.70
Daily oxygen		0.8736	<0.01	1.708–3.360	2.40
Behaviors—wandering		–0.2996	NS	0.531–1.035	0.74

*Site coefficients not shown.

[†]Reference categoryNonsignificant (NS) *P* values >0.05.

HR indicates hazard ratio; CI, confidence interval; ADL, activity of daily living; IADL, instrumental activity of daily living; SPMSQ, Short Portable Mental Status Questionnaire; Dx, diagnosis; COPD, chronic obstructive pulmonary disease.

whom patients coreside. Furthermore, our findings do not support those postulates, which suggest that the quantity of social support relationships or the intensity of the support provided could act to reduce mortality. We do not find that multiple informal caregivers or the time spent in providing informal support are significantly associated with mortality.

The provision of meals is the only type of informal support provided that promotes survival in this population. Meals are provided by those who coreside with the PACE

participant (spouse, children, or others) or by other informal caregivers who live elsewhere. Because PACE provides home delivered meals to all the participants who need them, including those who have informal caregivers, this finding might not be about the caloric content of meals consumed. One interpretation could be that the relationship between meals provided by the informal caregivers and mortality reflects the affective dimension of providing nutrition and the presence of a meaningful relationship with the informal

TABLE 4. Incremental Explanatory Power of Sociodemographic, Health Needs, Site, and Social Support: Mortality Hazard Models

Model Statistics	Model 1: Socio demographics	Model 2: Model 1 + Health Needs	Model 3: Model 2 + Site Indicator Variable	Model 4: Model 3 + Social Support
<i>Overall model</i>				
χ^2	67.6753	258.1492	318.1819	343.2036
df	6	18	32	40
P value	<0.0001	<0.0001	<0.0001	<0.0001
<i>Model χ^2 improvement*</i>				
χ^2	67.6753	190.4739	60.0327	25.0217
df	6	12	14	8
P value	<0.0001	<0.0001	<0.0001	<0.0015
Percent of model fit (incremental-explained entropy)	19.72%	55.50%	17.49%	7.29%

*Likelihood ratio.

caregiver. In fact, studies have shown that among the elderly, eating alone is associated with worse dietary intake than when one eats with others.³⁷ Suda and colleagues found that nutritional risk of persons living alone is reduced when those delivering Meals-on-Wheels socialize with the elderly persons while they ate their meal.³⁸

The importance of meals provided by informal caregivers could also be the result of the fact that caregivers are more knowledgeable about, and attentive to, the culinary preferences of their family member, and thus the meals they prepare are preferred over those delivered by Meals-on-Wheels. It has been shown elsewhere that lack of nutritional appeal in Meals-on-Wheels was 1 of the reasons older persons discontinue participating in this service.³⁹ Finally, it is also possible that in some cases, meals provided by the PACE programs are not sufficient to meet the needs of the participants. Studies have shown that weight loss is an important risk factor for mortality among older individuals.^{40,41} In fact, we do observe substantial variations in the effect of the PACE-site indicator on mortality, and further explorations of reasons for this variation could be subject for future research.

In conclusion, our study shows that certain aspects of informal caregiving are important factors enhancing survival in a population of very frail, nursing home-certifiable individuals who are enrolled in a health program that provides extensive services, including personal care, chores, and meals. This suggests that informal caregiving has an incremental positive effect on survival compared with formal care alone. Further research to better differentiate between the affective versus the instrumental dimensions of social support is needed to guide programs such as PACE on how to balance the use of resources to provide both the necessary formal services and the support for the informal caregivers.

REFERENCES

1. Kunitz SJ. Accounts of social capital: the mixed health effects of personal communities and voluntary groups. In: Leon DA, Walt G, eds. *Poverty, Inequality, and Health*. London: Oxford University Press; 2001:159–174.
2. Rogers RH. The effects of family composition, health, and societal support linkages on mortality. *J Health Social Behav*. 1996;37:326–338.
3. Berkman LF. Assessing the physical health effects of social networks and social support. *Annu Rev Public Health*. 1984;5:413–432.
4. Kunitz SJ, Levy LE. *Navajo Aging: The Transition From Family to Institutional Support*. Tuscon: University of Arizona Press; 1991.
5. Reed D, McGee D, Yano K. Psychosocial processes and general susceptibility to chronic disease. *Am J Epidemiol*. 1984;119:370.
6. Ho SC. Health and social predictors of mortality in an elderly Chinese cohort. *Am J Epidemiol*. 1991;130:100–111.
7. Rook KS. The negative side of social interaction: impact on psychological well being. *J Pers Soc Psychol*. 1984;46:1097–1108.
8. Rook KS, Pietromonaco P. Close relationships: ties that heal or ties that bind? *Advances in Personal Relationships*. 1987;1:1–35.
9. House JS, Landis KR, Umberson D. Social relationships and health. *Science*. 1988;241:540–545.
10. Wolinsky FD, Johnson RL, Stump TE. The risk of mortality among older adults over an eight-year period. *Gerontologist*. 1995;35:150–161.
11. Lillard LA, Waite LJ. Til death do us part: marital disruption and mortality. *Am J Sociol*. 1995;100:1131–1156.
12. Sugisawa H, Liang J, Liu X. Social networks, social support, and mortality among older people in Japan. *J Gerontol B Psychol Sci Soc Sci*. 1994;49:S3–S13.
13. Boulton C, Kane RL, Louis T, et al. Chronic conditions that lead to functional limitations in the elderly. *J Gerontol*. 1994;49:M28–M36.
14. Seeman TE, Kaplan GA, Knudson L, et al. Social network ties and mortality among the elderly in the Alameda County Study. *Am J Epidemiol*. 1987;126:714–723.
15. Baumann A, Filipiak B, Stieber J, et al. [Family status and social integration as predictors of mortality: a 5-year follow-up study of 55- to 74-year-old men and women in the Augsburg area]. *Z Gerontol Geriatr*. 1998;31:184–192.
16. House JS, Robbins C, Metzner HL. The association of social relationships and activities with mortality: prospective evidence from the Tecumseh Community Health Study. *Am J Epidemiol*. 1982;116:123–140.
17. Williams R, Barefoot J, Califf R, et al. Prognostic importance of social and economic resources among medically treated patients with angio-

graphically documented coronary heart disease. *JAMA*. 1992;267:520–524.

18. Eng PM, Rimm EB, Fitzmaurice G, et al. Social ties and change in social ties in relation to subsequent total and cause-specific mortality and coronary heart disease incident in men. *Am J Epidemiol*. 2002;155:700–709.
19. Berkman LF. The role of social relations in health promotion. *Psychosom Med*. 1995;57:245–254.
20. Bovard EW. *Perspectives on Behavioral Medicine*. New York: Academic Press; 1985.
21. Kiecolt-Glaser JK, Dura JR, Speicher CE, et al. Spousal caregivers of dementia victims: longitudinal changes in immunity and health. *Psychosom Med*. 1991;53:345–362.
22. Berkman LF, Syme L. Social networks, host resistance, and mortality: nine-year follow-up study of Alameda County residents. *Am J Epidemiol*. 1979;109:186–204.
23. Pruchno RA, Michaels JE, Potashnik SL. Predictors of institutionalization among Alzheimer disease victims with care giving spouses. *J Gerontol B Psychol Sci Soc Sci*. 1990;45:s259–s266.
24. Chatterji P, Burstein NR, Kidder D, et al. *Evaluation of the PACE Demonstration: The Impact of PACE on Participant Outcomes*. Abt Associates, Inc; 1998:1–61.
25. Eng C, Pedulla J, Eleazer PG, et al. Program of All-inclusive Care for the Elderly (PACE): an innovative model of integrated geriatric care and financing. *J Am Gerontol Soc*. 1997;45:223–232.
26. Covinsky KE, Eng C, Lui LY, et al. Reduced employment in caregivers of frail elders: impact of ethnicity, patient clinical characteristics, and caregiver characteristics. *J Gerontol A Biol Sci Med Sci*. 2001;56:M707–M713.
27. House JS, Kahn RL, McLeod JD, et al. Measures and concepts of social support. In: Cohen S, Syme SL, eds. *Social Support and Health*. New York: Academic Press, Inc; 1985:83–108.
28. Willis T. Supportive functions of interpersonal relationships. In: Cohen S, Syme SL, eds. *Social Support and Health*. New York: Academic Press, Inc; 1985:61–82.
29. Berkman LF. The relationship of social networks and social support to morbidity and mortality. In: Cohen S, Syme SL, eds. *Social Support and Health*. New York: Academic Press, Inc; 1985:241–262.
30. Mukamel DB, Temkin-Greener H, Clark ML. Stability of disability among PACE enrollees: financial and programmatic implications. *Health Care Financ Rev*. 1998;19:83–100.
31. Temkin-Greener H, Meiners MR, Gruenberg L. PACE and the Medicare+choice risk-adjusted payment model. *Inquiry*. 2001;38:60–72.
32. Pfeiffer E. A short portable mental status questionnaire for the assessment of organic brain deficit in elderly patients. *J Am Gerontol Soc*. 1975;23:433–441.
33. Cox DR. Regression models and life tables. *J R Stat Soc*. 1972;34:187–220.
34. Cox DR. Partial likelihood. *Biometrika*. 1975;62:269–276.
35. Tan EJ, Lui L, Eng C, et al. Differences in mortality of black and white patients enrolled in the program of all-inclusive care for the elderly. *J Am Gerontol Soc*. 2003;51:246–251.
36. Gibson RC. The age-by-race gap in health and mortality in the older population: a social science research agenda. *Gerontologist*. 1994;34:454–462.
37. de Castro JM. Heritability of diurnal changes in food intake in free-living humans. *Nutrition*. 2001;17:713–720.
38. Suda Y, Marske CE, Flaherty JH, et al. Examining the effect of intervention to nutritional problems of the elderly living in an inner city area: a pilot project. *J Nutr Health Aging*. 2001;5:118–123.
39. Choi NG. Determinants of frail elders' length of stay in Meals on Wheels. *Gerontologist*. 1999;39:397–404.
40. Frisoni GB, Franzoni S, Rozzini R, et al. Food intake and mortality in the frail elderly. *J Gerontol A Biol Sci Med Sci*. 1995;50:203–210.
41. Lasheras C, Fernandez S, Patterson AM. Mediterranean diet and age with respect to overall survival in institutionalized, non-smoking elderly people. *Am J Clin Nutr*. 2000;71:987–992.

Appendix 1 Mortality—Proportionate Hazard Model in PACE: Impact of PACE Site Indicators, Controlling for Personal Characteristics

PACE Site and Rank	Parameter Estimate	P Value* <0.05	95% HR CI Limits	Hazard Ratio	
	A	−2.0932	0.0374	0.017–0.885	0.123
	B	−1.4607	NS	0.032–1.669	0.232
	C	−0.9897	0.0347	0.148–0.931	0.372
	D	0.3826	NS	0.925–2.324	1.466
	E	0.4054	NS	0.881–2.553	1.500
	F	0.42605	0.0304	1.041–2.252	1.531
	G	0.4291	0.0177	1.077–2.190	1.536
PACE site (compared with mean)	H	0.4436	NS	0.918–2.647	1.558
	I	0.4646	0.0422	1.017–2.491	1.591
	J	0.7164	NS	0.988–4.241	2.047
	K	0.8154	0.0068	1.252–4.080	2.260
	L	0.8539	<0.0001	1.667–3.310	2.349
	M	0.87658	0.0047	1.308–4.414	2.403
	N	0.9029	0.0030	1.358–4.480	2.467

*P values >0.05 are not displayed.
 Nonsignificant (NS) P values >0.05.
 PACE indicates Programs of All-Inclusive Care for the Elderly; HR, hazard ratio; CI, confidence interval.