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Social Support and Stroke and Coronary Heart Disease
The JPHC Study Cohorts II

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Background and Purpose—Studies conducted in Western countries have found a robust association between social support and cardiovascular outcomes (eg, prognosis after myocardial infarction and functional recovery after stroke). However, less is known about the influence of social support on the same outcomes among Asian populations. In this prospective cohort study, we sought to examine the impact of social support on the incidence and mortality of coronary heart disease and stroke among the Japanese.

Methods—We examined prospectively the association between social support and risk of coronary heart disease and stroke incidence and mortality within a cohort of 44 152 Japanese men and women aged 40 to 69 years, free of previous diagnosis of cancer and cardiovascular disease. A total of 301 cases of newly diagnosed coronary heart disease, 1057 strokes, 191 coronary heart disease deaths, and 327 stroke deaths occurred between the baseline questionnaire (1993–1994) and the end of follow-up in January 2004.

Results—The multivariate hazard ratios and 95% CI for stroke mortality in the highest social support versus lowest social support group was 1.45 (1.00 to 2.10) overall, 1.59 (1.01 to 2.51) for men, and 1.25 (0.63 to 2.46) for women. Social support was not associated with stroke incidence or coronary heart disease incidence and mortality.

Conclusions—Low social support was associated with higher risk of stroke mortality in men. However, social support was not associated with stroke incidence, suggesting social support may be more important in stroke prognosis than preventing incidence. **(*Stroke*. 2008;39:768-775.)**

Key Words: coronary heart disease ■ follow-up study ■ social support ■ stroke

Social support, particularly emotional support, has been linked to improved prognosis after myocardial infarction (MI)[1–4] and improved functional recovery after stroke[5–7] in observational studies. The association between social support and cardiovascular disease prognosis has been shown to be independent of clinical markers of disease severity. Few studies have demonstrated an association between social support and incidence of cardiovascular disease.[8,9]

The mechanisms underlying the association between social support and cardiovascular disease prognosis have not been completely elucidated, although plausible explanations include improved adherence to medical regimens, behavior change (eg, smoking cessation after heart attack), as well as buffering of stress through neuroendocrine mechanisms.[10,11] Despite the wealth of observational studies suggesting a link between social support and cardiovascular disease prognosis, 2 major gaps in knowledge remain. First, the few randomized controlled trials among coronary disease and stroke survivors that were specifically designed to increase perceived social support have not borne out the findings of the observational studies, ie, they have yielded null results with respect to improvements in prognosis or functional recovery.[12,13] Although the results of randomized trials may signify that social support is not a causal determinant of cardiovascular disease prognosis, an alternative interpretation is that effective interventions to deliver social support in clinical settings have yet to be devised. The randomized trials conducted so far have attempted to deliver social support through cognitive behavioral therapy,[12] social support groups,[12] or family systems interventions.[13] One possibility is that the duration, timing, or intensity (ie, the "dose") of social support provided in these trials to cardiovascular disease survivors was insufficient to affect clinical prognosis. Alternatively, it is possible that only

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some patient subgroups benefited from social support provision. For example, in the Enhancing Recovery In Coronary Heart Disease Trial, social support appeared to benefit coronary disease recurrence and mortality outcomes in men but not in women, so that the overall results were null.[14] Further studies are thus warranted to determine whether social support can be effectively packaged and delivered in clinical settings to improve cardiovascular prognosis.

Meanwhile, a second gap in knowledge concerns the lack of studies on social support and health in non-Western countries. The majority of studies in this area have been conducted in North America and Europe, and it is not established whether similar patterns occur in other contexts and cultures where the meanings "social support" may differ within social relationships. For example, in Japanese culture, which is characterized by extensive patterns of reciprocity and exchanges of favors (especially within kinship ties), a high level of social support may simultaneously imply a high level of indebtedness to others as well as obligations to reciprocate favors. The meaning of social support (and, hence, the health consequences) may further vary according to gender. We therefore sought to test the association between social support and cardiovascular incidence and prognosis within a large-scale Japanese cohort study.

Materials and Methods

Study Cohort

The first cohort of the Japan Public Health Center-based Prospective Study (JPHC Study) was initiated in 1990 (cohort I), whereas the second cohort was initiated in 1993 (cohort II) within 27 administrative districts throughout the country. Details of the study have been described elsewhere.[15] The present study was conducted in the second cohort, because items on social support were not included in cohort I. In brief, the study population was defined as all residents (n=62 398) aged 40 to 69 years at baseline who had registered in 13 administrative districts. Of these residents, 102 residents were excluded because of non-Japanese nationality (n=22) and late reports of emigration occurring before the start of the follow-up period (n=80). Therefore, 62 296 residents were remained eligible for the study. A baseline self-administered questionnaire on various lifestyles was given to residents in 1993 and 1994; 52 234 residents responded to the questionnaire and were included in the study cohort. The overall response rate was 84%. The JPHC Study was approved by the institutional review board of the National Cancer Center, Tokyo Japan.

Baseline Questionnaire Survey

A baseline self-administered questionnaire on various lifestyles was given to participants in 1993 and 1994. The questionnaire included personal and family medical history, psychosocial factors such as perceived stress, perceived social support, and personality, and lifestyle factors such as smoking and alcohol habits, dietary habits, and physical activity. Perceived emotional support was defined as receipt of confidant support and esteem support from family members or friends. Confidant support was assessed by 2 items: "Do you have someone that you can share your intimate feelings and secrets with? (no or yes)" and "Do you have someone that you feel safe and comfortable with? (no or yes)". Esteem support was assessed by a single item: "Do you have someone who is supportive of your opinions and actions? (no or yes)". Social isolation was defined as not having a friend whom the respondent knew well enough to meet at least once per week; it was assessed by the item: "How many friends do you meet at least once per week: none, 1 to 3 friends, more than 4 friends?". These 4 items were then combined into an overall index of social support. Questions with yes/no responses were scored 1/0, whereas the question with 3 response categories were scored from 0 ("none") to 2 for the highest category. Thus, the overall index of social support had a possible range from 0 (lowest social support) to 5 (highest level of social support). The index had acceptable internal consistency reliability (Cronbach α coefficient of 0.75). The items on social support in the JPHC study were modeled after existing social support scales.[16] A total of 45 972 participants provided valid responses to all of these questions. We also excluded 1820 participants from the analysis because of history of MI, angina pectoris, stroke, or cancer at study baseline. Therefore, a total of 20 985 men and 23 167 women were used for the analysis.

Confirmation of Coronary Heart Disease and Stroke Incidence

A total of 34 hospitals were registered within administrative districts of the JPHC cohort. All were major hospitals with the capability of treating patients with acute coronary heart disease and stroke. Physicians blinded to the patients' lifestyle data reviewed the medical records at each hospital. Acute coronary and stroke events were included in the study if they occurred after the date of return of the baseline questionnaire and before January 1, 2004.

Myocardial infarction was confirmed in the medical records according to the criteria of the MONICA (Monitoring Trends and Determinants of Cardiovascular Disease) project,[17] which requires evidence from ECGs, cardiac enzymes, or autopsy. In the absence of a diagnosis of MI, deaths that occurred within 1 hour from onset of symptoms were regarded as sudden cardiac deaths.

Strokes were confirmed according to the criteria of the National Survey of Stroke,[18] which requires the presence of focal neurological deficits of sudden or rapid onset lasting at least 24 hours or until death. Strokes were further classified as subarachnoid hemorrhage, intraparenchymal hemorrhage, or ischemic stroke (thrombotic or embolic). All registered hospitals were equipped with computer tomographic scans or magnetic resonance scans. A definite diagnosis was established based on examination of CT or MRI images or autopsy.

To complete the surveillance for nonfatal MI and stroke, we asked participants by letter or telephone concerning the occurrence of coronary or stroke events and sought permission to review relevant medical records. Altogether 148 subjects reported a diagnosis of MI and 379 subjects reported a diagnosis of stroke by the 10-year follow-up questionnaire and had not already been registered as having had a coronary or stroke event by the procedures described. Of the 148 individuals reporting MI, 127 (86%) were contacted and 47 provided information consistent with suspected MIs. Of these 47 individuals, 39 (83%) provided written informed consent for their medical records to be reviewed by physicians. Among these participants, we confirmed definite MIs in 30 individuals, and these cases were therefore included among definite MIs in the analysis. Of the 379 individuals reporting stroke, 340 (90%) were contacted and 76 provided information consistent with suspected strokes. Of these 76 individuals, 62 (82%) provided written informed consent for their records to be reviewed by physicians. Among these participants, we confirmed definite strokes in 57 individuals, who were thus included in the analyses.

Confirmation of Coronary Heart Disease and Stroke Mortality

All death certificates were forwarded centrally to the Ministry of Health, Welfare, and Labor and coded for the National Vital Statistics. Registration of death is required by the Family Registration Law and is believed to be complete in Japan. The underlying causes of deaths were defined according to the International Classification of Diseases, 10th Revision as follows: deaths from stroke (codes I60 to I69), for each subtype of stroke, ie, subarachnoid hemorrhage (I60), intraparenchymal hemorrhage (I61), and ischemic stroke (I63), and coronary heart disease (I20 to I25). Coronary and stroke deaths were included in the analyses if they occurred after the

Table 1. Distribution of Baseline in a Cohort of 44 152 Men and Women According to the Levels of Social Support

	Men				Women			
	Very High	High	Medium	Low	Very High	High	Medium	Low
Social support score	5	4	2–3	0–1	5	4	2–3	0–1
N at risk	5930	8181	4393	2481	6910	10 563	3926	1768
Mean age, yr	53.9	53.0	53.0	53.2	55.3	53.4	53.2	53.0
Mean ethanol intake, g/wk	322.1	302.4	320.8	318.9	98.5	89.7	122.0	136.4
Heavy alcohol intake,* %	33.2	31.8	33.8	31.3	1.2	0.9	1.5	1.7
Mean body mass index, kg/m^2	23.8	23.4	23.3	23.2	23.7	23.4	23.4	23.3
Current smoker, %	54.0	52.7	51.9	50.8	5.9	6.2	6.4	7.3
Physical activity, %	25.6	20.0	15.8	12.2	26.2	17.9	14.5	10.5
Sedentary,† %	56.8	64.6	73.1	79.8	65.2	74.7	80.2	86.1
Active,‡ %	14.7	10.1	8.8	7.2	13.8	9.5	8.0	6.0
History of hypertension, %	21.2	20.4	21.2	22.3	20.5	20.5	20.8	21.4
History of diabetes, %	6.6	7.4	8.3	7.1	3.1	3.8	3.9	4.0
High stress, %	17.9	19.1	21.6	24.5	13.2	15.4	19.5	25.3
Unemployed, %	6.1	8.6	10.0	15.0	10.0	11.2	12.3	14.6

*Heavy alcohol intake: ≥450 mg/wk.
†Sedentary: No leisure time activity.
‡Active: ≥3–4 d/wk leisure time activity.

date of return of the baseline questionnaire and before January 1, 2004. Among the study subjects, 3094 died, 2756 moved out of the study areas, and 22 were lost to follow-up within the 10-year follow-up period.

Statistical Analysis

Person-years were counted from the date of the return of the baseline survey until one of the following end points. For the analysis of coronary heart disease or stroke incidence, person-years were censored at the date of disease diagnosis, the date of emigration from the study area, the date of death, or the end of study period (December 31, 2003), whichever came first. For the analysis of coronary heart disease and stroke deaths, person-years were censored at the date of emigration from the study area, the date of death, or the end of the study period, whichever came first. For persons who were lost to follow-up, the last confirmed date of their presence in the study area was used as the date of censoring.

Analysis of covariance and χ^2 tests were used to compare sex-specific age-adjusted mean values and proportions of cardiovascular risk factors, using the Dunnett multiple comparison method. The outcomes for this study were defined as newly occurring coronary heart disease and stroke incidence and deaths during the study period. Hazard ratios (HRs) and their 95% CIs were calculated after adjustment for age and other potential confounding factors using Cox proportional-hazards models. Confounding variables included age (years), smoking status (never, former, or current), ethanol intake (nondrinkers and former drinkers, less than weekly, <150 g/wk, or ≥150 g/wk), body mass index (kg/m^2 in quartiles), leisure time sports activity (<1 day/mo, 1 to 3 days/mo, or ≥1 day/wk), perceived stress (less, moderate, or high) and occupation (unemployed, housewife, professional, managerial, administrative, sales and services, manual labor, farming, forestry, fishery, or others). To check for effect modification, we also stratified analyses according to age group (40 to 64 years and 65 years or older), risk profile (with and without history of hypertension, diabetes, and past or current smoking), and high perceived stress (yes and no). We also checked for statistical interactions by using cross-product terms of social support and stratifying variables. We tested the assumption of proportional hazards by using both time-dependent covariate method and linear correlation test and found no violation of proportionality. All analyses were conducted using the SAS statistical package Version 9.1 (SAS Institute Inc).

Results

During 470 734 person-years of follow-up (average follow-up period, 10.7 years) a total of 301 cases of newly diagnosed coronary heart disease (219 men and 82 women), 1057 strokes (637 men and 420 women), 191 coronary heart disease deaths (131 men and 60 women), and 327 stroke deaths (200 men and 127 women) occurred among the 44 152 subjects (20 985 men and 23 167 women).

We separately examined social support in relation to cardiovascular risk factors among men and women (Table 1). Subjects were categorized into 4 levels of social support based on the distribution of our combined index: low (scores of 0 or 1, 10%), medium (scores of 2 or 3, 19%), high (score of 4, 42%), or very high (score of 5, 29%). Men with lower levels of social support were younger ($P<0.001$), less likely to be current smokers ($P=0.02$), and more likely to have lower body mass index ($P<0.001$). Lower social support among men was also associated with sedentary lifestyle ($P<0.001$), higher perceived stress ($P<0.001$), and higher unemployment rate ($P<0.001$). Among women, lower social support was associated with younger age ($P<0.001$), more sedentary lifestyle ($P<0.001$), higher perceived stress ($P<0.001$), higher unemployment rate ($P<0.001$), lower body mass index ($P=0.008$), as well as high ethanol intake ($P=0.03$).

Table 2 shows the HRs of incidence and mortality from coronary heart disease and stroke according levels of social support. For men and women combined, persons with the lowest level of social support had ≈1.5-fold higher risk of mortality from stroke in multivariable-adjusted models (P for linear trend: 0.03). Men with the lowest level of social support had a 1.6-fold higher risk of mortality from stroke in

Table 2. Age-Adjusted and Multivariable HR and 95% CIs for Coronary Heart Disease and Stroke Incidence and Mortality According to the Level of Social Support

	Incidence					Mortality				
	Very High	High	Medium	Low	*P* for Trend	Very High	High	Medium	Low	*P* for Trend
Social support score	5	4	2–3	0–1		5	4	2–3	0–1	
N at risk	12 840	18 744	8319	4249		12 840	18 744	8319	4249	
Person-years	130 662	191 087	84 705	42 579		136 942	200 456	88 514	44 822	
Stroke, n	339	400	198	120		86	126	70	45	
Age, gender-adjusted RR	1.0	0.89 (0.77–1.03)	0.96 (0.80–1.14)	1.12 (0.91–1.39)	0.29	1.0	1.12 (0.85–1.48)	1.36 (0.99–1.86)	1.68 (1.17–2.41)	0.002
Multivariable-adjusted RR	1.0	0.90 (0.78–1.04)	0.95 (0.80–1.14)	1.11 (0.89–1.37)	0.38	1.0	1.07 (0.81–1.41)	1.26 (0.92–1.74)	1.45 (1.00–2.10)	0.03
Coronary heart disease, n	93	117	58	33		63	59	46	23	
Age, gender-adjusted RR	1.0	0.95 (0.72–1.25)	0.97 (0.70–1.35)	1.04 (0.70–1.55)	0.85	1.0	0.71 (0.50–1.02)	1.18 (0.80–1.72)	1.11 (0.69–1.80)	0.22
Multivariable-adjusted RR	1.0	0.93 (0.71–1.23)	0.92 (0.66–1.28)	0.90 (0.60–1.35)	0.59	1.0	0.70 (0.49–1.01)	1.13 (0.77–1.66)	1.00 (0.61–1.63)	0.44
Men										
N at risk	5930	8181	4393	2481		5930	8181	4393	2481	
Person-years	58 998	81 373	43 756	24 386		62 426	86 230	46 193	25 798	
Stroke, n	187	231	138	81		46	73	47	34	
Age, gender-adjusted RR	1.0	0.95 (0.78–1.15)	1.06 (0.85–1.32)	1.11 (0.86–1.44)	0.27	1.0	1.22 (0.85–1.77)	1.48 (0.99–2.23)	1.90 (1.22–2.96)	0.002
Multivariable-adjusted RR	1.0	0.96 (0.79–1.17)	1.04 (0.83–1.30)	1.09 (0.84–1.43)	0.40	1.0	1.17 (0.81–1.70)	1.35 (0.90–2.04)	1.59 (1.01–2.51)	0.03
Coronary heart disease, n	59	87	44	29		42	37	32	20	
Age, gender-adjusted RR	1.0	1.12 (0.80–1.56)	1.06 (0.72–1.56)	1.24 (0.80–1.94)	0.44	1.0	0.67 (0.43–1.05)	1.10 (0.69–1.74)	1.22 (0.72–2.08)	0.18
Multivariable-adjusted RR	1.0	1.10 (0.79–1.54)	0.99 (0.67–1.47)	1.06 (0.68–1.67)	0.98	1.0	0.69 (0.44–1.07)	1.06 (0.67–1.68)	1.12 (0.65–1.94)	0.33
Women										
N at risk	6910	10 563	3926	1768		6910	10 563	3926	1768	
Person-years	71 664	109 714	40 949	18 193		74 516	114 226	42 321	19 024	
Stroke, n	152	169	60	39		40	53	23	11	
Age, gender-adjusted RR	1.0	0.83 (0.66–1.03)	0.80 (0.59–1.08)	1.21 (0.85–1.72)	0.75	1.0	1.02 (0.67–1.53)	1.21 (0.73–2.03)	1.35 (0.69–2.63)	0.28
Multivariable-adjusted RR	1.0	0.85 (0.68–1.06)	0.83 (0.61–1.12)	1.22 (0.85–1.74)	0.65	1.0	0.99 (0.65–1.50)	1.15 (0.68–1.93)	1.25 (0.63–2.46)	0.43
Coronary heart disease, n	34	30	14	4		21	22	14	3	
Age, gender-adjusted RR	1.0	0.68 (0.42–1.11)	0.87 (0.46–1.61)	0.58 (0.21–1.65)	0.35	1.0	0.81 (0.44–1.47)	1.42 (0.72–2.79)	0.71 (0.21–2.38)	0.82
Multivariable-adjusted RR	1.0	0.67 (0.41–1.10)	0.84 (0.45–1.59)	0.55 (0.19–1.57)	0.30	1.0	0.77 (0.42–1.41)	1.28 (0.64–2.55)	0.58 (0.17–1.99)	0.86

Adjusted for age, gender, body mass index, smoking, alcohol consumption, perceived stress, occupation, physical activity, and history of hypertension and diabetes.
RR indicates relative risk.

multivariable-adjusted models (*P* for linear trend: 0.03). However, social support was not statistically significantly associated with risk of stroke mortality in women (although the social support/sex interaction term did not reach formal levels of statistical significance; *P* for interaction: 0.16). We also found no significant associations between social support and incidence of stroke or coronary heart disease in either men or women. We further examined the associations between levels of social support and mortality from specific stroke subtypes (data not shown). We found no difference in the associations between subtypes of stroke mortality. For example, the multivariable HRs for mortality (95% CI) for the highest social support versus lowest social support groups were 1.53 (0.81 to 2.90) for intraparenchymal hemorrhagic stroke and 1.34 (0.64 to 2.80) for ischemic stroke.

Tables 3 and 4 show the HRs of incidence and mortality from coronary heart disease and stroke, respectively, according to levels of each constituent item that make up the social support index. Social isolation was associated with ≈1.6-fold higher multivariable-adjusted risk of stroke mortality for men and women combined. The lack of confidant support, especially item 1 (lacking someone to share intimate personal feelings and secrets), was also associated with 1.2-fold higher multivariable-adjusted risk of stroke incidence for men and women combined. Among men, social isolation and the lack of esteem support were associated with 1.5- to 1.8-fold higher risks of stroke mortality, and the lack of someone to share personal feelings and secrets was associated with 1.2-fold higher risk of stroke incidence. In contrast to men, no significant associations were found for any of the outcomes for women. Thus, the combined findings for men and women appear to be driven by the associations among men.

We next checked for potential effect modification by stratifying the analyses by age group (40 to 64 and 65 to 69 years), cardiovascular risk profile (with and without history of hypertension, diabetes, and past or current smoker), and high levels of perceived stress (yes and no) (data not shown). We found there was an interaction by age for the association between social support and stroke incidence (despite no association being found for subjects overall). The excess risk of stroke incidence was stronger in older persons with lower levels of social support (HR, 1.62; 95% CI, 1.12 to 2.35) compared with younger persons (HR, 0.93; 95% CI, 0.72 to 1.21; for interaction, $P=0.07$), but there was no interaction by age for stroke mortality. There were no statistically significant interactions between social support and perceived stress status or cardiovascular risk profile for any of the outcomes studied.

Discussion

In this large prospective analysis in a Japanese population, we found that after adjustment of potentially confounding variables, the risk of mortality from stroke was 1.6-fold higher for men with the lowest levels of social support compared with those with the highest levels. The association between low social support and stroke mortality was not statistically significant in women. Furthermore, we found no associations between social support and the incidence of stroke or coronary heart disease. We found some evidence of effect modification by age, ie, there was a suggestion of an effect of

Table 3. Age-Adjusted and Multivariable HR and 95% CIs for Coronary Heart Disease and Stroke Incidence According to Social Isolation, Esteem Support, and Confidant Support

	Social Isolation			Esteem Support		Confident Support*		Confident Support†	
	≥4 Friends	1–3 Friends	No Friends	Yes	No	Yes	No	Yes	No
N at risk	15 075	23 229	5848	38 162	5990	36 178	7974	35 721	8431
Person-years	153 663	236 703	58 668	388 494	60 541	368 640	80 394	363 188	85 846
Stroke, n	388	542	127	887	170	830	227	843	214
Age, gender-adjusted RR	1.0	1.00 (0.88–1.14)	0.97 (0.79–1.18)	1.0	1.20 (1.01–1.41)	1.0	1.20 (1.03–1.39)	1.0	0.99 (0.86–1.16)
Multivariable-adjusted RR	1.0	1.01 (0.88–1.15)	0.98 (0.80–1.20)	1.0	1.16 (0.99–1.37)	1.0	1.18 (1.01–1.37)	1.0	0.97 (0.83–1.13)
Coronary heart disease, n	118	146	37	255	46	234	67	235	66
Age, gender-adjusted RR	1.0	0.89 (0.70–1.14)	0.87 (0.60–1.25)	1.0	1.08 (0.79–1.48)	1.0	1.17 (0.89–1.54)	1.0	1.04 (0.79–1.36)
Multivariable-adjusted RR	1.0	0.87 (0.68–1.11)	0.79 (0.54–1.15)	1.0	0.96 (0.70–1.33)	1.0	1.08 (0.82–1.42)	1.0	0.96 (0.73–1.27)
Men									
N at risk	7234	10 452	3299	17 767	3218	16 309	4676	16 197	
Person-years	72 140	103 993	32 380	176 737	31 776	162 346	46 168	160 653	47 860
Stroke, n	220	327	90	525	112	474	163	490	147
Age, gender-adjusted RR	1.0	1.09 (0.92–1.29)	1.02 (0.80–1.31)	1.0	1.19 (0.97–1.46)	1.0	1.23 (1.03–1.47)	1.0	0.97 (0.81–1.17)
Multivariable-adjusted RR	1.0	1.10 (0.93–1.31)	1.03 (0.80–1.33)	1.0	1.15 (0.94–1.42)	1.0	1.21 (1.01–1.44)	1.0	0.94 (0.78–1.13)
Coronary heart disease, n	78	107	34	179	40	164	55	168	51
Age, gender-adjusted RR	1.0	1.00 (0.74–1.33)	1.06 (0.71–1.59)	1.0	1.24 (0.88–1.75)	1.0	1.19 (0.88–1.62)	1.0	0.99 (0.72–1.35)
Multivariable-adjusted RR	1.0	0.98 (0.73–1.32)	0.96 (0.64–1.45)	1.0	1.09 (0.77–1.54)	1.0	1.08 (0.80–1.48)	1.0	0.91 (0.66–1.24)
Women									
N at risk	7841	12 777	2549	20 395	2772	19 869	3298	19 524	3643
Person-years	81 522	132 711	26 288	211 756	28 764	206 294	34 227	202 534	37 986
Stroke, n	168	215	37	362	58	356	64	353	67
Age, gender-adjusted RR	1.0	0.89 (0.73–1.09)	0.89 (0.62–1.27)	1.0	1.21 (0.92–1.60)	1.0	1.13 (0.87–1.48)	1.0	1.05 (0.81–1.36)
Multivariable-adjusted RR	1.0	0.91 (0.75–1.12)	0.91 (0.63–1.31)	1.0	1.21 (0.91–1.60)	1.0	1.13 (0.87–1.48)	1.0	1.05 (0.80–1.36)
Coronary heart disease, n	40	39	3	76	6	70	12	67	15
Age, gender-adjusted RR	1.0	0.70 (0.45–1.09)	0.32 (0.10–1.05)	1.0	0.60 (0.26–1.39)	1.0	1.09 (0.59–2.02)	1.0	1.26 (0.72–2.20)
Multivariable-adjusted RR	1.0	0.68 (0.43–1.06)	0.31 (0.10–1.03)	1.0	0.57 (0.25–1.33)	1.0	1.05 (0.57–1.95)	1.0	1.24 (0.71–2.18)

Adjusted for age, gender, body mass index, smoking, alcohol consumption, perceived stress, occupation, physical activity, and history of hypertension and diabetes.
*Having someone who you can share intimate feelings and secrets with.
†Having someone who you feel safe and comfortable with.

social support on stroke incidence among subjects aged 65 years or older, but not for younger subjects (nor for the overall sample).

The relationship between social support and cardiovascular morbidity and mortality (particularly for coronary heart disease) has been well documented in previous studies conducted in western countries.[1–9] The effect of social support on coronary heart disease incidence and mortality after MI has been reported to be stronger in men than in women, and men appeared to be more likely than women to experience protective effects of social support on incidence[8,9] and prognosis[1] after coronary heart disease. However, the results form these studies may not be generalizable to other cultures. A prospective study among Japanese-American men residing in Hawaii reported that social networks were not associated with the incidence of nonfatal MI, although the study did not measure social support.[19]

In contrast to studies involving coronary heart disease outcomes, there have been far fewer studies of social support and stroke incidence or survival (although >70 studies have examined social support as a predictor of functional recovery after stroke).[6] A recent prospective study has reported that low social support was associated with fatal and nonfatal stroke incidence, although the association became nonsignificant after adjustment for stroke risk factors.[20]

Two distinct models have been proposed concerning the influence of social support on health outcomes. The "stress buffering" model posits that social support benefits health only in the presence of a stressor, whereas the "main effects" model posits that social support is beneficial regardless of the presence of stress. The new onset of stroke is a source of stress in patients' lives. Viewed this way, our findings support the stress-buffering model, ie, social support improved prognosis after the onset of stroke, but did not affect the risk of incidence. However, we did not find evidence of an interaction between social support and perceived stress in predicting stroke outcomes, although we hasten to add that stress was measured only at baseline, ie, predating the onset of stroke. The protective effect of social support on cardiovascular disease prognosis appeared to be specific to stroke in this Japanese cohort. In the present study, we found no difference in the association between subtypes of stroke mortality. Furthermore, we could find no association between social support and either coronary disease incidence or mortality.

Social support is hypothesized to buffer stress (and, hence, improve clinical outcomes) through multiple mechanisms, including improved therapeutic compliance (eg, not forgetting to take blood pressure medications) and accessibility to medical emergency care and treatment, health-promoting behavior change, as well as through direct neuroendocrine effects. With regard to the latter, social support may lead to more benign appraisals of stress and, hence, reduce or eliminate the affective reaction to a stressful event. Stress activates neuroendocrine components including the hypothalamic-pituitary-adrenal axis and the sympathetic nervous system.[12] The long-term activation of these axes may induce a sustained increase in cortisol,[12] norepinephrine secretions,[21] inflammatory proteins,[22] platelet abnormalities,[23] and endothelial dysfunction,[24] which may in turn

Table 4. Age-Adjusted and Multivariable HR and 95% CIs for Coronary Heart Disease and Stroke Mortality According to Social Isolation, Esteem Support, and Confidant Support

	Social Isolation			Esteem Support		Confidant Support*		Confidant Support†	
	≥4 Friends	1–3 Friends	No Friends	Yes	No	Yes	No	Yes	No
N at risk	15 075	23 229	5848	38 162	5990	36 178	7974	35 721	8431
Person-years	160 708	248 085	61 942	407 489	63 246	386 269	84 466	381 306	89 429
Stroke, n	99	170	58	265	62	250	77	260	67
Age, gender-adjusted RR	1.0	1.24 (0.97–1.59)	1.76 (1.27–2.44)	1.0	1.46 (1.11–1.93)	1.0	1.35 (1.04–1.74)	1.0	1.01 (0.77–1.33)
Multivariable-adjusted RR	1.0	1.18 (0.92–1.52)	1.59 (1.14–2.22)	1.0	1.32 (0.99–1.74)	1.0	1.24 (0.96–1.61)	1.0	0.96 (0.73–1.25)
Coronary heart disease, n	75	88	28	157	34	147	44	146	45
Age, gender-adjusted RR	1.0	0.85 (0.62–1.15)	1.07 (0.69–1.65)	1.0	1.33 (0.91–1.92)	1.0	1.25 (0.89–1.76)	1.0	1.17 (0.84–1.64)
Multivariable-adjusted RR	1.0	0.82 (0.60–1.13)	1.01 (0.65–1.58)	1.0	1.22 (0.83–1.77)	1.0	1.17 (0.83–1.65)	1.0	1.11 (0.79–1.56)
Men									
N at risk	7234	10 452	3299	17 767	3218	16 309	4676	16 197	4788
Person-years	76 144	110 058	34 446	187 216	33 432	171 693	48 955	170 493	50 155
Stroke, n	55	100	45	154	46	143	57	153	47
Age, gender-adjusted RR	1.0	1.34 (0.96–1.86)	2.06 (1.39–3.06)	1.0	1.67 (1.20–2.32)	1.0	1.42 (1.05–1.93)	1.0	1.00 (0.72–1.39)
Multivariable-adjusted RR	1.0	1.26 (0.90–1.76)	1.84 (1.22–2.75)	1.0	1.45 (1.03–2.03)	1.0	1.28 (0.94–1.75)	1.0	0.93 (0.67–1.29)
Coronary heart disease, n	50	55	26	105	26	95	36	98	33
Age, gender-adjusted RR	1.0	0.80 (0.55–1.18)	1.29 (0.80–2.07)	1.0	1.39 (0.90–2.13)	1.0	1.35 (0.92–1.98)	1.0	1.10 (0.74–1.64)
Multivariable-adjusted RR	1.0	0.80 (0.54–1.18)	1.27 (0.78–2.07)	1.0	1.27 (0.82–1.96)	1.0	1.26 (0.86–1.87)	1.0	1.04 (0.70–1.55)
Women									
N at risk	7841	12 777	2549	20 395	2772	19 869	3298	19 524	3643
Person-years	84 564	138 027	27 496	220 273	29 814	214 576	35 511	210 813	39 274
Stroke, n	44	70	13	111	16	107	20	107	20
Age, gender-adjusted RR	1.0	1.14 (0.78–1.66)	1.25 (0.67–2.33)	1.0	1.10 (0.65–1.87)	1.0	1.19 (0.74–1.92)	1.0	1.06 (0.65–1.70)
Multivariable-adjusted RR	1.0	1.11 (0.75–1.62)	1.19 (0.63–2.23)	1.0	1.05 (0.62–1.78)	1.0	1.13 (0.70–1.83)	1.0	1.00 (0.62–1.61)
Coronary heart disease, n	25	33	2	52	8	52	8	48	12
Age, gender-adjusted RR	1.0	0.95 (0.56–1.60)	0.34 (0.08–1.46)	1.0	1.18 (0.56–2.49)	1.0	0.98 (0.47–2.07)	1.0	1.42 (0.75–2.68)
Multivariable-adjusted RR	1.0	0.87 (0.51–1.48)	0.30 (0.07–1.30)	1.0	1.04 (0.49–2.20)	1.0	0.85 (0.40–1.81)	1.0	1.32 (0.70–2.50)

Adjusted for age, gender, body mass index, smoking, alcohol consumption, perceived stress, occupation, physical activity, and history of hypertension and diabetes.
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exacerbate other cardiovascular risk factors such as hypertension,[12,25] heart rate,[26] hyperlipidemia,[12] diabetes,[12] and the progression of atherosclerosis.[12] By promoting more benign appraisals of stress, social support may reduce the intensity or duration of these neuroendocrine responses.

In the present study, a protective effect of social support on stroke mortality was found in Japanese men, but not in women. A possible reason for this gender-based discrepancy may be that, unlike the case of men, Japanese women are more likely to be exposed to tight interpersonal relationships involving reciprocity exchanges. Many of the study subjects in the present study were recruited from Japanese rural areas (Mito, Kashiwazaki, Kamigotou, and Miyako), which are characterized by dense networks involving reciprocity and mutual aid, especially among middle-aged women. A recent study suggested that the stress buffering effect of social support on depressive symptoms were significant only for middle-aged Japanese men.[27] Japanese men tend to participate in more activity-oriented relationships, whereas women tend to maintain more emotionally intimate relationships.[28] In the present study, women were more likely to report receiving emotional support than men, even though they were less likely to benefit from support in terms of stroke outcomes. For example, the proportion of those who received confidant support, ie, the positive response to the either of the 2 related questions, was higher in women (78%) compared with men (69%). The JPHC Study did not assess provision of social support to others. However, it is possible that in the Japanese context, reporting high receipt of social support (specifically among women) may be a marker for higher provision of social support to others (and, hence, higher levels of stress associated with feelings of indebtedness and expectations to reciprocate).

We note several limitations of our study. First, there is the possibility of residual confounding by unmeasured variables such as personality and negative emotions. Second, social support was assessed in our study through simple questions relating to emotional support and social isolation. We did not specifically inquire about other aspects of social support such as instrumental support or different sources of social support (eg, from health care professionals, community-based organizations, voluntary groups, neighbors, etc). Thus, we were unable to pin down the domains of social support that are most effective in influencing outcomes after stroke. Finally, because the study was not designed to analyze the effect of transitions, we were not able to assess changes in social support as a predictor of cardiovascular disease outcomes. For example, poststroke disability may lead to greater social isolation as a result of difficulties with communication (eg, dysarthrias or aphasia) as well as withdrawal form community activities.

The strengths of our study are its prospective design and large sample size, yielding good statistical power for detecting the effects of social support, stratified by gender. We were also able to distinguish between the effects of social support on disease incidence versus disease prognosis.

In summary, low social support was associated with a higher risk of stroke mortality, especially for Japanese men. However, social support was not associated with stroke incidence, suggesting social support may be more important

in promoting recovery than in preventing disease. Our findings have health policy relevance given the current decline in the marriage rate in Japan[29] as well as the rapid population aging in that society.[29]

Appendix

Study Group Members

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Disclosures

None.

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