Using geographical distance among family members from the electoral list as a measure of the intensity of social networks of the elderly in Costa Rica[1].

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Abstract

The first-wave questionnaire of the project CRELES (Costa Rican Study of Longevity and Healthy Aging) collects a limited amount of information about social support of the Costa Rican elderly. We use information from Costa Rica's electoral list linked to the CRELES main dataset to establish the electoral district of residence of CRELES respondents' siblings. Then, using the geographical coordinates of the centroids of the electoral districts, we compute mean geographical distances between each CRELES respondent and his/her siblings, as well as several dichotomous variables that measure proximity. We then compare these geographical measures with other indexes used in CRELES to assess social support and social networks in order to inspect its external validity. Finally, we run several logistic and regression models that have health indicators as dependent variables, to see whether geographical distance as a proxy for social distance is associated with health status in Costa Rica.

Introduction

Costa Rica is the country with the highest life expectancy in Latin America, with levels that are similar to industrialized countries, like the U.S. The project CRELES (Costa Rican Study of Longevity and Healthy Aging) has been started to investigate the reasons of this particular longevity in a developing country. One of the study's hypotheses is whether the extent of the networks of social support available to the old age population contributes to healthy aging (Puga

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et al, 2006; Glaser *et al*, 2007). Research done in developed countries shows that there is a positive association between the strength of social relationships and good health (Carpiano, 2006; Holtzman, 2004; House, Landis and Umberson, 1988; Kawachi, Kennedy and Glass, 1999; Mendes de Leon *et al*, 2001; Unger *et al*, 1999). Besides, in Latin America, social support for the elderly is relatively more common than in industrialized countries because of the prevalence of certain types of living arrangements, the availability of kin due to higher fertility levels, and –possibly– cultural norms about how family is viewed (Bongaarts and Zimmer, 2002; Palloni, 2001; Saad, 2003).

In the data analysis process, researchers in the CRELES project noticed that the first wave questionnaire does not contain as many questions to study social networks as other projects about aging (Puga et *al*, 2006). However, Costa Rica has the advantage that the government collects a very diverse set of administrative information in a very centralized way with unified standards of data collection. This administrative information is relatively easy to manage because Costa Ricans have a unified identification card called "cedula" which was originally established for electoral purposes, but is used for almost every administrative activity needed by a Costa Rican citizen (e.g., cashing checks, signing a legal contract, proving adult age, etc.). The identification number is also the same as the one in the driver's license, passport, and Social Security number.

One of the most complete administrative records set in Costa Rica is the electoral list ("padron electoral"), which contains the id number, as well as the real name (with both parents' family names), and the electoral district where the person lives. We use the electoral list to determine the electoral district of residence of CRELES respondents' siblings, and then we compute distances between respondents' and their siblings' electoral district of residence.

Sibling ties

The family is one of the primary sources for establishing social networks and finding social support. Social research has stressed the importance of spouses and children in providing social support, but members of the extended family also play a role in the constitution of social networks, especially in familistic cultures (Portes, 1998). Sibling ties appear to be different than

other kinds of social relationships. Although some authors find that sibling relationships vary according to the degree of emotional closeness within the dyad (Campbell, Connidis and Davies, 1999; Connidis, 1989; Lee, Mancini and Maxwell, 1990), Miner and Uhlenberg find that conversations and companionship appear to characterize the roles of brothers and sisters more often than the exchange of social support. Burhold and Wenger (1998) classify them as loose-knit relationships more frequently than relationships with children.

There is evidence that the frequency and strength of sibling relationships decrease by age (White, 2001; White and Riedman, 1992), although at very old ages in some countries there is a plateau in the association (Burholt and Wenger, 1998). Several characteristics might explain this pattern. Full siblings show more stable sibling dyads than step-siblings or half-siblings (White and Riedmann, 1992), but relationships with the latter are more frequent when there are no full siblings. Childless or formerly married (widowed, divorced, seaprated) elderly are more likely to establish ties with their siblings (Campbell, Connidis and Davies, 1999; Connidis, 1989; Miner and Uhlenberg, 1997); these associations suggest that adults who lack social support from spouses and children develop social networks with available kin. Women tend to report more frequent and stronger relationships with their sisters (Campbell, Connidis and Davies, 1999; Connidis, 1989). In the United States (U.S.), African-Americans and Latinos also report having more social networks with siblings than whites (Miner and Uhlenberg, 1997; White, 2001).

Strength and frequency of sibling ties is consistently associated with geographical proximity (Burholt and Wenger, 1998; Lee, Mancini and Maxwell, 1990; Litwin, 1995, 1998; White and Riedmann, 1992). Persons are more likely to consider a brother or sister as a confidant if they live closer to each other (Campbell, Connidis and Davies, 1999; Connidis and Davies, 1992). Greater distance between siblings is associated with less person-to-person and telephone conversations –but with more contact by mail–, seeing a sibling less often, fewer talks about important matters, and not having a sibling as preferred contact, regardless of gender, marital status, or childlessness (Connidis, 1989). Greater contact and exchange among brothers and sisters among African Americans, Latinos, less educated, and formerly married people is mediated by geographical proximity; this suggests that sibling ties among African Americans might be explained by residential segregation rather than by just cultural norms (White, 2001).

Regarding elderly in need of care, proximity increases the likelihood of providing care by male kin, but females provide care regardless of geographical distance (Joseph and Hallman, 1998).

Datasets

The main dataset for this study is the one generated by the project CRELES, the Costa Rican Study on Longevity and Healthy Aging. It is an on-going longitudinal study of a nationally representative sample of 2,827 adults born in 1945 or before (ages 60 and over at the first interview) and residing in Costa Rica by the year 2000, with over-sampling of the older old. For this analysis we use the data for the first wave of interviews, conducted from November 2004 through September 2006. This sample size was obtained from a two-step procedure. First, an original sample of 9,600 individuals was randomly selected from the 2000 census database with stratification by 5-year age groups. Sampling fractions ranged from 1.1% among those born in 1941-45 to 100% for those born before 1905. Next, for the in-depth longitudinal study we are analyzing here, a sub-sample of 60 "health areas" (out of 102 for the whole country) was taken with probability proportional to the population ages 60 and over. This sub-sample included near 5,300 individuals. The sub-sample, which covers 59% of Costa Rican territory, yielded the following non-response rates: 19% deceased by the contact date; 18% non-found in the field; 2% moved to other addresses; 2% rejected the interview; 2% pendant interviews after several visits (likely rejections). From those interviewed: 95% provided blood sample; 91% had anthropometric measures; 24% required a proxy to answer the questionnaire. All field data were collected using Personal Digital Assistants (PDAs), also known as palm computers, with software applications developed by CCP for this study. All data and specimens in the study were collected at the participants' homes, usually in two visits. In the first visit, participants provided informed consent and answered a 90-minute long questionnaire (including some mobility tests and two blood-pressure measures) as well as a 10-minute frequency of tracer food consumption questionnaire. In a second visit early next day, fasting blood samples were collected by venipuncture: 1 EDTA purple top tube (for 3-4 ml. of whole blood) and 2 serum separating tubes (SST), with a clot activator (for 10-12 ml. of blood, to obtain 4-6 ml. of serum). In this visit the field team also picked up a cooler containing 12-hour overnight urine and took the anthropometric measures. All field data were collected using Personal Digital Assistants

(PDAs), also known as palm computers, with software applications developed by CCP for this study.

The new social support questions are asked in the second wave. The second wave fieldwork started in 2006 and it is still going on. Attrition rates are not known yet, although an approximate estimate based on completed interviews is around 12%, excluding attrition due to mortality. The interview procedure is the same that was followed during the first wave, although there is a new proxy questionnaire for deceased individuals.

The dataset with administrative records is the electoral list, called "padron electoral". Currently, the electoral list contains around 2 million records. The electoral list is compiled and produced by the Civil Registry, which is a Government agency that is part of the Supreme Electoral Tribunal. The Civil Registry is also the institution that records all the births, deaths, and marriages in the country. This allows the Civil Registry to clearly determine when a person turns 18 years old, and therefore becomes a citizen, with all the electoral rights and obligations to which the person is entitled. Deaths are also used to exclude decedents from the electoral list. The Civil Registry is the institution that assigns the unique identification number mentioned above to every Costa Rican. The id number is assigned at birth, and includes the number of province, ledger, and page where the person is registered. The ledgers are uniquely and sequentially numbered, since the Civil Registry system was established around 1880.

An extended version of the electoral list requested by the Central American Center for Population to the Supreme Electoral Tribunal contains not only the unique id number, the complete names, and electoral district of residence, but also the names of each individual's mother. CRELES sampled individuals were matched to the Civil Registry using id numbers (cedulas). A person is considered a sibling of another person if both people share the same mother's name, as well as the paternal and maternal family names[2]. This decision rule means that persons with the same mother but with different fathers are not considered siblings. A sample of 50 respondents from CRELES total sample of 2,827 were selected randomly and a

[2] Unlike the U.S.A., Costa Ricans use regularly their paternal and maternal family name. For example, if Costa Rican, John F. Kennedy would have been called John Kennedy Fitzgerald.

thorough search for siblings was performed (using other matching criteria) in order to test the error introduced by the decision rule. Only 4 persons were found that had more siblings than what the decision rule established, and this occurred because of differences in how their mothers' names were recorded.

Distance and social support measures

As mentioned before, for most of the people, the electoral district records contain the name of the person's parents. Therefore, with the electoral list, it is possible to establish for every person, the electoral district where their siblings live, as long as they live within the country's territory. The Central American Center for Population has the geographical coordinates of the centroid of every electoral district in the country. Therefore, for every elderly person in the CRELES sample (2,827 persons), we will establish the following measures about geographical distance of the family network:

a) mean distance between the sampled person and every one of his/her siblings;
b) maximum distances between sampled person and siblings;

Pitagoras's linear distances are computed based on the following formula:

$$d_{ij} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2} ,$$

where i denotes CRELES respondents; j, their siblings; and x and y are the longitude and latitude measured in kilometers.

Aside from mean and maximum distances, we compute the following additional independent variables about geographical proximity among siblings:

a) Number of siblings that are alive;
b) Whether there is any sibling living in the same household (derived from the household roster CRELES questionnaire);

c) Whether there is any sibling living in the same electoral district as respondent;
d) Number of siblings living in the same electoral district as respondent;
e) Percentage of total siblings living in the same electoral district as respondent:

We compare these measures with a set of questions in CRELES wave 2 that were constructed to assess social support. These questions are about whether Costa Rican elderly think that they (a) receive invitations for amusement or distraction, (b) receive love and support, (c) can talk with someone about personal problems, (d) can talk with someone at home or at work, (e) can talk with someone about economic problems, (f) have people that care about them, (g) get advice from anyone, and (h) get help when ill. These questions are not asked to proxy respondents. The answers to these questions are operationalized using a scale with the following categories: never, a few times, sometimes, frequently. The association between distance measures and these questions are analyzed using odds ratios estimated from ordinal logistic regressions, which control for confounding variables: age, sex, living in the Central Valley, education, number of chronic diseases reported by respondents, number of children alive, and living arrangements (living alone, only with spouse, or with others), and marital status (in union, single, and other).

Finally, using correlation coefficients (biserial-point and Spearman rank correlations), we study what the degree of association is between distance measures and selected health measures (self-rated health, urinary cortisol levels, and depression). Depression is measured with a variation of Yesavage's Geriatric Depression Scale based on 15 items. Cortisol levels are measured from urine samples collected overnight. We selected these three health measures because they are related to health dimensions that can be buffered by social support (Antonucci, Fuhrer and Dartigues, 1997; Clark, Bond and Hecker, 2007; House, Landis and Umberson, 1988; Kawachi, Kennedy and Glass, 1999). All correlation coefficients are partial, adjusted by the same confounding variables mentioned above.

Results

Of CRELES total sample of 2827 individuals, there is information about mothers' names in only 2618 cases. Another 122 cases are excluded because the centroids of siblings' electoral district

of residence are missing in the Civil Registry dataset, so the total sample size for the initial analysis is 2496. According to the match, 27% have no siblings alive at all –either because all of them died or because they have no siblings at all– (Table 1). Fertility was considerably high among these generations' parents, given that another 27% of CRELES respondents have 5 siblings alive or more (Graph 1). On average, Costa Rican elderly have around 4 brothers and sisters that were alive at the interview period. Among those with siblings, only 5% live with them in their houses (according to CRELES data, not to the matching process), although 45% live in the same district as their brothers and sisters. On average, 24% of siblings live in the same district as CRELES respondents (Table 1).

Association between distance measures and social support questions are analyzed only among people that do not need proxy respondents in the second wave. We are excluding proxy respondents as well as losses to follow-up either because of rejection to interview, mortality, or other reasons of attrition. Size of the subsample also varies according to the social support questions given that some of them have higher proportions of non-response answers than others. Size of subsamples can be observed in Table 2 with odds ratios from ordinal logistic regressions, the measure of association selected to analyze these items. We expect to find odds ratios greater than one (positive association) with number of siblings alive, whether siblings in same household, whether siblings in same district, and percentage of siblings living in same district because the positive association means that more siblings and more geographical proximity towards siblings translates into more social support. We expect to find odds ratios smaller than one (negative association) with whether no siblings alive, and with mean and maximum distance because the negative association means that more distance between respondent and siblings (or absence of siblings) translate into less social support. Distance measures are logged to control skewness in these variables.

In the set of ordinal logistic models (Table 2), not all odds ratios for distance measures are significantly different to one. Significant odds ratios of receiving invitations to distractions are observed for the variables of number of siblings alive, percentage of siblings living in same district and the dummy variables of whether siblings in same household and siblings in same district. There is also a significant odds ratio for the variable of no siblings alive, which is in the

opposite direction as what was expected. Living with siblings in the same district is significantly associated also with receiving love and support, talking to someone about personal problems or about economic problems, and talking to someone at home or in household. Percentage of siblings living in same district is significantly associated with receiving love and support, talking to someone about personal problems, having people that care about respondents, and getting useful advice when something happens. Finally, the odds ratios associated with mean logged distance are significantly different to one in the equations about receiving love and support, talking to someone about personal problems, and talking to someone at work or in household.

The analysis of the association between distance measures and selected health measures are shown in Table 3. In all three selected health variables (self-rated health, urinary cortisol, and depression scale), large values refer to bad health and small values to good health. The expected direction of the correlation coefficients is the opposite of the direction in the odds ratios estimated with the ordinal logistic regressions. We expect to find negative associations of health variables with number of siblings alive, whether siblings in same household, whether siblings in same district, and number and percentage of siblings living in same district (more siblings available, worse health), and positive associations with whether no siblings alive, and with mean and maximum distance (longer distance, worse health).

As with ordinal logistic regressions, most of the correlation coefficients are small and non-significant. Mean and maximum distances to siblings are significantly associated (using Spearman rank correlation coefficient) with self-rated health after controlling for other confounding variables. This means that people who live further away from their siblings rate their health worse than people whose siblings live closer. However, the size of the coefficients is small. The dichotomous variable of whether siblings in the same district and number of siblings in the same district have a significant negative association with depression. The direction of the association coefficients is the expected one, although the size of the coefficients is small, too (around -0.06). A significant association in the opposite direction to what was expected was found between the variable of no siblings alive and depression, given that those with no siblings have on average a smaller value in the depression scale.

Discussion

The idea that "geographical distance" represents "social distance" has been an important motif for developments in human geography and other social sciences (Anselin, 1999). Although the external validity of this statement varies according to the problem that is studied, the notion is important when information is scarce. This paper had the aim to fulfill a methodological shortcoming: the absence of good social support questions in the first wave of a survey about aging in a Latin American country, Costa Rica. It has been argued that social support is a key element in understanding health and aging in societies characterized by a familistic culture. The role played by social support might be stronger among these generations of Costa Ricans, given that Costa Rica is a very small country in terms of territory and population. Less than a million people were living in Costa Rica when these cohorts were born. The typical anecdote of the mid-20th century Costa Rica was that everybody knew each other. Social support from siblings might also be important among these generations given that fertility was considerably high when they were born and hence more siblings were around.

The main conclusion from this analysis is that these distance measures among siblings are weakly correlated with social support and health indicators. Whereas with the social support measures, the association coefficients for having no siblings at all have a direction that is opposite to what was expected, the few significant association coefficients in the analysis of health variables do have the expected direction (except the figure for depression and having no siblings). The analysis suggests that availability of siblings in the "neighborhood" might buffer depression and the feeling of being sick. This interpretation has to be made with caution given that there might be some reverse causation in the association; e.g., people who were sick or depressed move to places near where their relatives live, or their relatives might have moved to be close to their sick kin. This is why we decided to use correlation coefficients rather than regression models. It is interesting, too, that none of the distance measures are significantly associated with urinary cortisol, a biomarker biologically linked to stress (Clark, Bond and Hecker, 2007).

Regarding the association with the set of social support questions included in CRELES second wave questionnaire, the mixed results suggest that physical distance with siblings might be related to some dimensions of social support, but not to all. It is interesting to notice that most distance measures are consistently associated with having invitations for amusement and distraction in the expected direction. This does not necessarily happens with the other social network items, and this agrees somehow with Burhold and Wenger's (1998) classification of sibling ties as loose-knit ties. Availability of siblings might be important for social gatherings and entertainment, but not necessarily for important conversations or receiving support. Distance measures that refer to siblings in the district (but not in the household) are related –and in the expected direction– with such deeper dimensions as receiving love and care and having important conversations. Brothers and sisters living close but in other households seem to be an important source of friendship and emotional support. This finding agrees with significant associations between these variables and depression: depression is inversely associated with having siblings living in the same district, but not with number of siblings in general or with siblings in the same household.

More analyses and data are needed to explore how good these distance measures are, so they can be used for analyzing the role of social support on Costa Ricans' exceptional longevity. However, limitations in the matching process and data might be yielding spurious correlations due to measurement biases. One of these limitations is the fact that only "full" siblings –and not half siblings, step siblings, and "informally adopted" siblings– are classified as such. White and Riedmann's (1992) finding that relationships with full siblings is more prevalent than relationships with half or step siblings might be used to justify the adequacy of this limitation. However, Costa Rican elderly's familistic behaviors might be considerably different than American elderly's. Cohabitation, "out-of-wedlock" children, and extended families (where second-degree and higher-degree kin were treated as brothers and sisters) were common in Costa Rica when these generations were born.

Another limitation is that the variable "mother's name" in the Civil Registry database might have been recorded differently for different siblings. A sensitivity analysis performed with a

subsample of 50 observations suggests that this problem is not too frequent. However, a more thorough analysis should be performed.

Finally, the social support questions included in the second wave questionnaire are asked only to non-proxy respondents. This limitation might be introducing a bias because we can not assess what is the importance of geographical proximity to people that are the sickest and therefore need proxy respondents.

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Graph1. Number of alive siblings. Costa Rica: People age 60 and over, 2004-2006.

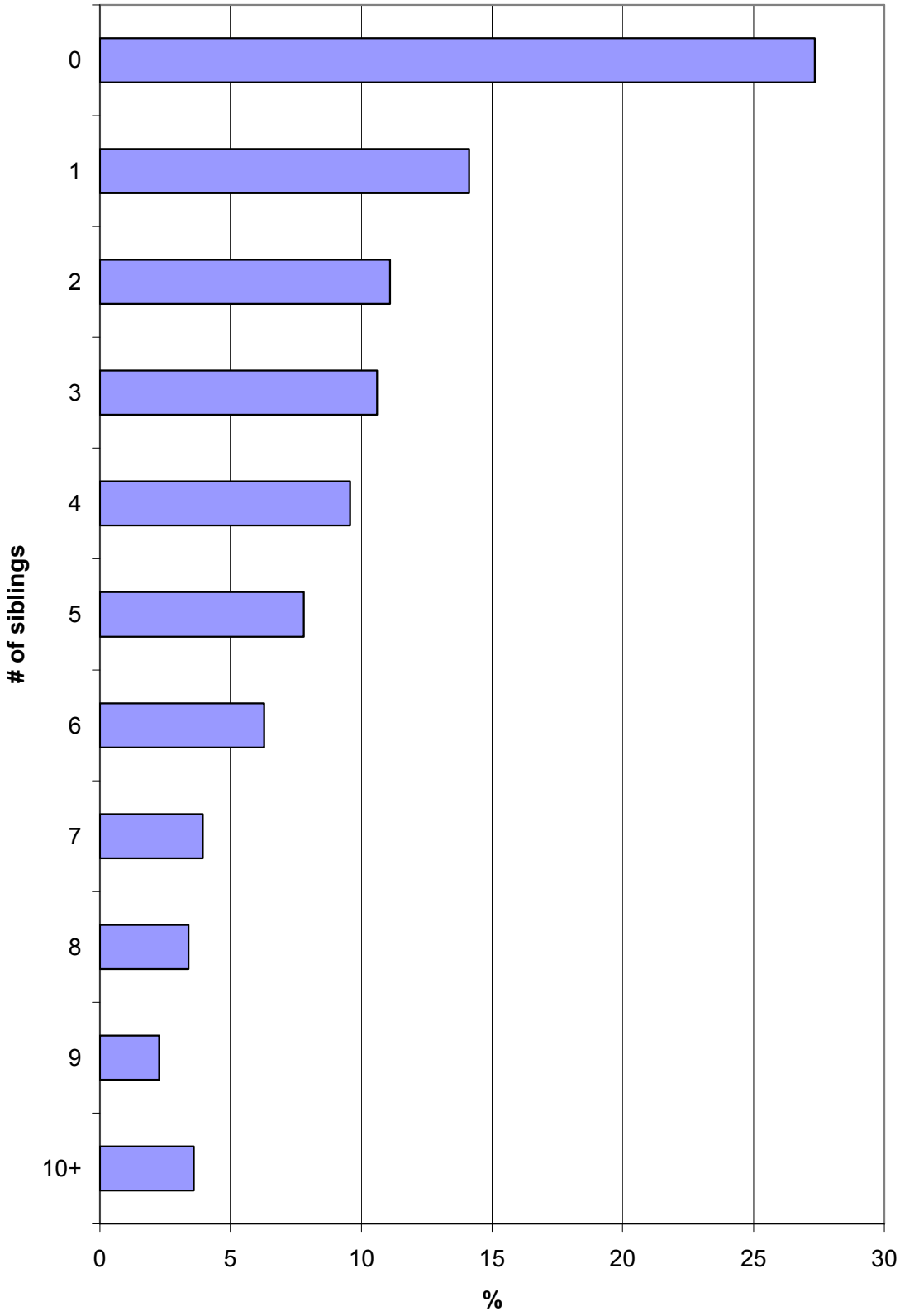

Table 1. Descriptive statistics of distance to siblings' residence 1/. Costa Rica: People age 60 and over, 2004-2006.

Descriptive statistics of distance		
% with no siblings alive (n=2496)	27.4	
Among people with siblings (n=1662):		
--Mean number of siblings alive (sd)	4.1	(2.7)
--% with siblings in same household	5.1	
--% with siblings in same district	44.9	
--Mean number of siblings living in same district (sd)	1.0	(1.6)
--Mean percentage of siblings living in same district (sd)	24.2	(33.4)
Among people with siblings in different district (n=1510):		
--Mean distance to siblings' residence in Km (sd)	30.1	(42.8)
--Maximum distance to any sibling's residence in Km (sd)	65.9	(77.2)

Note: 1/ Sibling residence defined as the centroid of the district where sibling lives.

Table 2. Odds ratios for items of social support by siblings' distance measures, computed from ordinal logit models, and adjusted by several covariates 3/.

Siblings' distance measures	Social Support: Invitations to distractions		Social Support: Receive love and support		Social Support: Talk to someone about personal problems		Social Support: Talk to someone at work or in hh	
	(n)	OR	(n)	OR	(n)	OR	(n)	OR
No siblings alive	1334	1.06**	1334	1.03	1303	1.02	1292	1.02
Among people with siblings								
--Number of siblings alive	930	1.05*	930	1.01	910	1.01	903	1.02
--With siblings in same hh	930	1.80*	930	1.29	910	1.89	903	1.51
--With siblings living in same county	930	1.43**	930	1.59*	910	1.38*	903	1.45**
--Percentage of siblings living in same county	930	1.01**	930	1.01**	910	1.01*	903	1.01
Among people with siblings in different county								
--With mean distance (ln)	864	0.99	863	0.93*	845	0.95*	839	0.94*
--With maximum distance (ln)	864	0.96	863	0.92	845	0.93	839	0.96

Notes: 1/hh=household
2/ Standardized depression scale based on Yesavage's scale.
3/ Adjusted by age, sex, living in the Central Valley, education, number of chronic diseases reported by respondents, number of children alive, and living arrangements, and marital status.
*: $p<0.05$, **: $p<0.01$

Table 2. Odds ratios for items of social support by siblings' distance measures, computed from ordinal logit models, and adjusted by several covariates 3/.
(Continue…)

Siblings' distance measures	Social Support: Talk to someone about economic problems		Have people that care about you		Get useful advice when something happens		Get help when ill	
	(n)	OR	(n)	OR	(n)	OR	(n)	OR
No siblings alive	1235	1.03	1335	0.98	1310	0.99	1199	1.05
Among people with siblings								
--Number of siblings alive	861	1.02	931	0.98	921	0.99	834	1.05
--With siblings in same hh	861	1.22	931	0.77	921	1.43	834	1.26
--Number of siblings living in same county	861	1.37*	931	1.27	921	1.34	834	1.24
--Percentage of siblings living in same county	861	1.01*	931	1.01*	921	1.01*	834	1.00
Among people with siblings in different county								
--With mean distance (ln)	802	0.96	864	0.99	855	0.97	772	0.98
--With maximum distance (ln)	802	0.93	864	0.98	855	0.96	772	0.98

Notes: 1/hh=household
2/ Standardized depression scale based on Yesavage's scale.
3/ Adjusted by age, sex, living in the Central Valley, education, number of chronic diseases reported by respondents, number of children alive, and living arrangements, and marital status.
*: $p<0.05$, **: $p<0.01$

Table 3. Association statistics with selected health measures: Biserial point correlation coefficients for dichotomous variables and Spearman rank correlation coefficients for scalar distance indicators variables. (Adjusted by several covariates 3/).

Siblings' distance measures	**Health measures** Self-rated health		Urinary cortisol (mg/dl)		Depression scale 2/	
	(n)	cor	(n)	cor	(n)	cor
No siblings alive	2287	-0.017	1894	-0.009	1811	-0.051 *
Among people with siblings						
--Number of siblings alive	1528	0.013	1292	0.009	1266	-0.017
--With siblings in same hh	1525	0.030	1289	-0.014	1263	0.030
--With siblings in same district	1528	-0.018	1292	0.011	1266	-0.060 *
--Number of siblings living in same district	1528	-0.021	1292	0.020	1266	-0.063 *
--Percentage of siblings living in same district	1528	-0.027	1292	0.018	1266	-0.054
Among people with siblings in different county						
--With mean distance	1388	0.069 *	1173	-0.007	1266	0.011
--With maximum distance	1388	0.080 *	1173	-0.010	1165	0.038

Notes: 1/hh=household
2/ Standardized depression scale based on Yesavage's scale.
3/ Adjusted by age, sex, living in the Central Valley, education, number of chronic diseases reported by respondents, number of children alive, and living arrangements, and marital status.
*: $p<0.05$, **: $p<0.01$