Title

Social networks, social support, and life expectancy in older adults: the Cardiovascular Health Study.

Authors

Arnold, Alice

Newman, Anne

Mukamal, Kenneth

et al.

Publication Date

2023-08-01

DOI

10.1016/j.archger.2023.104981

Peer reviewed

HHS Public Access

Author manuscript

Arch Gerontol Geriatr. Author manuscript; available in PMC 2024 April 18.

Published in final edited form as:

Arch Gerontol Geriatr. 2023 August ; 111: 104981. doi:10.1016/j.archger.2023.104981.

SOCIAL NETWORKS, SOCIAL SUPPORT, AND LIFE EXPECTANCY IN OLDER ADULTS: THE CARDIOVASCULAR HEALTH STUDY

Roma Bhatia, MD[1], **Calvin Hirsch, MD**[2], **Alice M. Arnold, PhD**[3], **Anne B. Newman, MD, MPH**[4], **Kenneth J. Mukamal, MD, MPH**[5]

[1)]University of Michigan Medical Center, Ann Arbor, MI 48109

[2)]University of California Davis Medical Center, Sacramento, CA 95817

[3)]University of Washington, Seattle, WA 98115

[4)]University of Pittsburgh, Pittsburgh, PA 15261

[5)]Beth Israel Deaconess Medical Center, Boston, MA 02446

Abstract

Background: Social support and social networks have long been postulated to impact health outcomes but their impact on life expectancy and disability in older adults remains poorly quantified.

Methods: As part of the Cardiovascular Health Study, we followed 5,749 adults aged 65 years and older from 4 US field centers for 25 years. We assessed the Lubben social network score [range 0–50] and a social support score [range 0–24] derived from the Interpersonal Support Evaluation List (ISEL-12) in two consecutive years starting at study recruitment. We used remaining years of life (YOL) from study enrollment to death to approximate life expectancy. We defined years of active life (YAL) as the number of study years in which participants lived without any difficulties in activities of daily living. We used compression of disability to reflect the proportion of life lived able (YAL/YOL). We used linear regression to adjust for socio-demographics and comorbidity.

Results: The mean (standard deviation [SD]) scores were 32.3 ± 6.8 points for social network score and 8.3 ± 2.4 points for social support score. For every 1-SD increase in social network score, adjusted participant life expectancy was 0.40 years higher (95% CI 0.22–0.58; $p<0.0001$) and disability-free life expectancy 0.35 years higher (95% CI 0.18–0.53; $p<0.0001$). The association with life expectancy was modified by participant age ($p<0.001$), but it remained significant even among participants aged ≥75 years (3 months per SD; 95% CI 0.1–6 months, $p= 0.04$). Further adjustment for frailty did not attenuate the estimates. The social support scale

CORRESPONDING AUTHOR: Kenneth J. Mukamal, MD, BIDMC Division of General Medicine Research Section, 1309 Beacon Street, 2nd Floor, Brookline, MA 02446; kmukamal@bidmc.harvard.edu.

Author contributions: RB and KM planned the study. RB conducted the data analysis, and wrote the paper. KM supervised the analysis and provided revisions to the paper. CH, AA and AN contributed to the analysis plan and revisions of the paper.

Declaration of Conflict of Interest: No conflicts of interest are reported by the authors.

was not significantly associated with YOL or YAL after adjustment for social network score, and neither measure was associated with compression of disability.

Discussion: In older adults, higher social network scores are significantly associated with longer life expectancy and disability-free life expectancy.

Keywords

healthy aging; social support networks; social determinants of health; longevity

INTRODUCTION

Since the 1970s, social networks, or the intricate web of relationships or connections undertaken by an individual on a daily basis, have been postulated to affect the spectrum of health.[1] Features of social networks including size,[2,3] frequency of contact with members,[4] and network diversity[5] have all been implicated in modulating the health effects of social networks. Less robust social networks, in particular, have been associated with more frequent hospital visits, primary care visits, and higher health care costs.[6] Social networks are also thought to be associated with lower risk of mortality,[2,7–9] although characterizing who benefits[10,11] and the magnitude of the benefit[12–15] remain actively debated. In addition, stronger social networks have been thought to have a protective effect on development of disability in older adults.[16,17]

Nonetheless, several issues remain to address. First, many prior studies reported unadjusted results or null, imprecise estimates with wide confidence intervals.[9] Second, to our knowledge, no prior studies have attempted to quantify absolute years of life lost or gained associated with social networks in older adults; these require essentially complete follow-up to death of most participants. Third, due to the complex interplay between underlying physical health, comorbidity burden, and social isolation, the directionality between underlying health and social networks, particularly in older adults, has been difficult to establish. In addition, it is unknown if strong social networks or social support systems can influence the relative compression of the disabled period, or the proportion of life spent with ADL difficulties, as has been postulated with a healthy lifestyle.[18] Thus, the exact contributions of social support and social networks to life expectancy, disability-free life expectancy, and compression of disability remain to be quantified.

To address these questions, we followed participants from the Cardiovascular Health Study (CHS). This ongoing population-based cohort study has followed 5888 adults aged 65 and older for over two decades and includes clinical, demographic, and sociological data. As a result, we were able to quantify the association of these complex social constructs on the most important of health outcomes – total and able years of life lived.

METHODS

Study participants

CHS is a longitudinal cohort study of 5,888 adults aged 65 years and older that was designed to understand the risk factors associated with development of cardiovascular disease and

stroke in older adults.[19] Starting in 1989, 5201 participants were recruited from 4 diverse field centers in the United States (Sacramento, CA; Hagerstown, MD; Winston-Salem, NC; and Pittsburgh, PA) using a random sample of Medicare eligibility lists. A cohort of 687 predominantly African-Americans was recruited from three of the original centers in 1992–1993. Participants were eligible if they were 65 years of age or older, demonstrated capacity for informed consent, were not wheelchair bound and were otherwise not receiving any chemotherapy, radiation therapy, or hospice services. Recruitment and periodic follow up efforts completed both by telephone and in person included health surveys, physical examination, laboratory measurements, and selected imaging. For these analyses, mortality ascertainment was complete through 25 years of follow-up.

All CHS participants provided written informed consent, and the study was approved by all participating field centers and the coordinating center at the University of Washington (approval numbers Johns Hopkins, 11007/CR811; University of Washington and ceded review from UC Davis, University of Pittsburgh, and Wake Forest University, CR00006343).

Exclusion Criteria

We excluded participants who were missing baseline social network (n=17) or social support scores (n=77) and excluded individuals who had missing data on underlying comorbidity burden or sociodemographic factors (n=45), leaving 5,749 participants in our analytic dataset (Supplementary Figure 1).

Social Support and Social Network Scores

Our primary exposures of interest were each participant's social network and social support scores. Upon enrollment, all participants completed two measures: the 10-item Lubben Social Network Scale and the 6-item Interpersonal Support Evaluation List (detailed instrument with questions provided in Supplemental Table 1).[20,21]

The Lubben scale screens for perceived social isolation and assesses social support in older adults by evaluating kin and non-kin ties. It assesses the number of relatives/friends that individuals feel close to, how frequently they see them, and overall the number of times they have contact with close friends/relatives per month. Each item is scored from 0–5 for a total score of 0–50.

The social support score for each participant was assessed using a survey adapted from the Interpersonal Support Evaluation List.[21] The instrument evaluates how well participants feel supported by their family and friends in daily life in 3 different support spectrums: belonging (i.e., "When I feel lonely, there are several people I can talk to"), appraisal (i.e., "When I need suggestions on how to deal with personal problem, I know someone I can turn to"), and tangible support (i.e., "If I were sick, I could easily find someone to help me with daily chores"). Items were rated on a 4-point scale from 1 (definitely false) to 4 (definitely true). Total scores ranged from 0–24.

These two scales were collected for both cohorts of participants at their respective baseline enrollment periods (1989/1990 or 1992/93) and at the field center visit the following year. To minimize misclassification, we averaged scores for each measure from the first two

consecutive years of follow-up for both cohorts; if the second score was missing, we used only the baseline value. We repeated all analyses with each cohort's baseline values only for both social support and social network scores as a sensitivity analysis.

Years of Life, Years of Active Life, and Compression of disability

Life expectancy was calculated as the remaining Years of Life (YoL) for each participant, which we defined as the time from study enrollment to death for each participant. At the end of 25-year follow-up, 546 participants were still alive. For these participants, their YOL beyond 24 years were imputed based on previous regression equations using factors such as age, race, sex, and self-rated health,[22] which have been widely used as outcomes in other CHS studies;[18,23] neither social support nor social network scores were part of the imputation.

Participants were also surveyed on a semi-annual or annual basis throughout follow up about any difficulty in completing activities of daily living (ADL) defined as: walking around the home, getting out of bed, eating, dressing, bathing, using the toilet. We used years of able life (YoAL) to depict the number of study years in which participants did not experience any difficulties completing any of the ADL tasks described above, using methods to deal with missing data as previously described elsewhere.[18,23] We defined compression of disability as the proportion of life lived without ADL disability (i.e., YoAL/YoL).

Statistical methods

We used a restricted cubic spline model[24] to test for linearity between life expectancy and social functioning and found no evidence of departure. We subsequently constructed multivariable linear regression models to quantify the relationships of years of life, years of able life, and compression of disability with social support and social networks, using the latter both as linear variables (as appropriate) and in tertiles.

We used baseline covariates that have been previously associated with life expectancy and are relevant in older adults,[18] including age, sex, education (< high school, high school, some college), field center, marital status, income, smoking (never, former, current) and alcohol use (any vs. no use). Clinical covariates included Digital Symbol Substitution Test score (a measure of cognitive processing speed), depressive symptoms assessed with the Center for Epidemiologic Studies-Depression Scale (CES-D), calculated body-mass index derived from measured height and weight, hypertension (systolic blood pressure ≥140/90 or use of antihypertensive medications), diabetes (fasting blood glucose ≥126 or use of antihyperglycemic medications), prevalent cardiovascular disease, and prevalent cerebrovascular disease.[25] In sensitivity analyses, we also adjusted for benzodiazepine use as a surrogate for anxiety, which was not assessed in CHS in a manner comparable to depressive symptoms.

We performed stratified analyses by age, sex, race, education, and frailty. The literature suggests that the association of social networks on health outcomes including longevity may be modified by an individual's age, sex, race, and education, and considerable differences exist in longevity by race.[26] Prior studies have also highlighted that frailty is independently associated with poor social functioning in older adults and that frail adults may have smaller

social networks.[27] Frailty was assessed based on 5 items: weight loss, weak grip strength, slow gait speed, exhaustion, and low energy expenditure.[28] Participants were classified as frail if they met 3 or more of the 5 criteria and as non-frail otherwise.

To better understand which of the individual items most strongly drove observed associations, we also determined the associations of YoL and YoAL years with each question of the social network and social support scales. However, because these scales have been validated in total, and not as subscales, these analyses should be considered exploratory.

SAS 9.4 was used for all analyses.

RESULTS:

Baseline characteristics:

Of the 5,749 CHS participants included, the mean age was 73, 84% were white, and two-thirds were married. The mean calculated social network score was 32.3 ± 6.8 [range 2.5–48.5]. The mean calculated social support score was 8.3 ± 2.4 [6–22.5]. Social network and social support scores were moderately correlated ($r=0.46$, $p<0.0001$).

Participant characteristics overall and according to social network scores are shown in Table 1. In general, participants with higher social network scores were younger, reported more years of schooling, and were more likely to be married. In contrast, baseline comorbidities, including hypertension, diabetes, stroke, congestive heart failure, did not differ according to social network tertile.

Associations with life expectancy:

The mean life expectancy was 14.1 (7.4) years, and the mean disability-free life expectancy was 10.2 (7.3) years.

After adjustment for the covariates listed in the methods including participant demographic factors and comorbidity burden, social network score was strongly associated with life expectancy (Table 2) and disability-free life expectancy (Table 3). The relationship was largely similar even with further adjustment for participant frailty and social support score. Further adjustment for benzodiazepine use had no further effect on these estimates (data not shown).

When examined in tertiles, individuals with the highest tertile of social network score had an average life expectancy approximately 9 months higher (Table 2) and a disability-free life expectancy of 8 months higher than those with the lowest tertile of social network score (Table 3). We observed no association between higher social network score and compression of disability (Table 3).

We did not find effect modification between social network score and life expectancy when conducting interaction analyses by gender ($p=0.73$), race ($p=0.45$), education ($p= 0.26$), and participant frailty ($p=0.82$). In contrast, we did observe statistically significant effect modification by participant age ($p<0.001$). For every 1 SD increase in the social network

score, participants aged 65–74 demonstrated 7 month longer life expectancy (95% CI 4 months-10 months, p<0.001), and participants aged 75+ demonstrated a 3 month longer life expectancy (95% CI 0.1 month-6 months, p= 0.04).

In contrast to social networks, after adjustment, social support score was less strongly associated with life expectancy and disability-free life expectancy compared to social network score. For every 1 SD increase in social support score, life expectancy increased by 2 months (95% CI 0.2 months-3 months, p=0.03), and disability-free life expectancy increased by 3.5 months (95% CI 1.5–5.5 months, p=0.004). However, after adjusting for social network score, the relationships between social support score and life expectancy (p=0.85) and disability-free life expectancy (p=0.06) were not statistically significant.

Supplemental Table 2 provides the estimates for life expectancy and disability-free life expectancy associated with specific questions in each scale. One item on the social support scale was strongly associated with these outcomes (I often meet or talk with family or friends), but it essentially duplicated similar questions in the social network scale. Two other questions related to finding someone to help with chores or with house-sitting were also associated at somewhat more modest levels of significance. Three social network questions were particularly strongly associated with both outcomes, all related to family ties.

DISCUSSION

In a longitudinal cohort of 5,749 community dwelling older adults, we observed a clear dose-response relationship between the strength of an older adult's social network and subsequent life expectancy, even after adjustment for comorbidities, education levels and socioeconomic status. Higher social network scores were also associated with a higher proportion of time participants lived "healthy and able", i.e,. overall life years lived without disabilities. Together, these results highlight the profound impact of social networks on older adults.

In addition to the pronounced overall association of social network strength with longer life expectancy, we noted significant effect modification by age. In particular, the effect of social networks on life expectancy appeared to be the strongest for the "youngest old" (age 64–74) compared to those older than 75 years. This may be partially explained by our use of remaining years of life as an endpoint in this cohort of older adults. Those at older ages at recruitment into the study would by nature of these methods be subject to a ceiling effect that may reduce the effect of social networks seen on years of life seen in this age group. Nonetheless, our results do not suggest that social networks are unrelated to survival even in the oldest old; specifically, those 75 years and older experienced approximately 3 months longer life expectancy for every 1 SD increase in social network scores.

Compared to the social network score, perceived social support in our study had a relatively weaker association with adjusted life expectancy. Although speculative, we can theorize several explanations. First, as noted in the literature, social support is more likely to be influenced by psychological well-being than are social networks, such that an anxious or lonely individual may have adequate social support but report inadequate support due to

their underlying psychological health.[1] Although we adjusted for depressive symptoms, a lack of systematic anxiety screen in CHS limits our ability to account for the full psychological health of our respondents, and this may have impacted our ability to discern the true impact of social support on life expectancy. Third, some prior literature has found that after controlling for predictors of cardiovascular disease, as we have done in our model, social support was not significantly related to mortality. Thus, it may be that these factors, including age, gender, BMI, and other comorbidities, explains the majority of the variability in years of life between participants. Fourth, the social support scale does indeed capture elements of the strength of quality of relationships to a greater degree (as reflected, for example in its assessment of trust), while the social network scale reflects their quantity to a greater degree. However, even this difference may have multiple explanations; quantity may supersede quality because it is more important, or simply because it is easier to recall and measure.

The exact mechanism driving the relationship between higher social networks score and longer life expectancy is unclear, but several hypotheses spanning domains of psychosocial, environmental, and biological factors exist. Social networks are thought to promote health through a variety of mechanisms including: a) the provision of social support, or the degree to which individuals perceive/are championed within relationships; b) social influence (e.g. norms and social control); social engagement, d) interpersonal contact (critical for transmission of pathogens/behaviors), and e) access to resources (e.g., information, jobs, money).[29] In addition, stronger social networks may reduce feelings of loneliness which are thought to induce biological changes in cardiovascular, endocrine, and immune functioning which may predispose to illness.[30,31] Our results confirm, for the first time, that social networks are linked to absolute life expectancy and to disability-free life expectancy in older adults; because these two outcomes increased roughly in proportion, however, social network score was not associated with compression of disability.

There are several limitations to our study. First, although our cohort is biracial, the numbers of African Americans were limited, and there were few members of other races or ethnicities, thereby limiting our ability to test for effect modification. Second, not all participants were followed to death, therefore requiring imputation of remaining years of life. Third, although the specific scales we used to measure social networks and support have been systematically used in the literature, these remain complex constructs, and we may have misclassified the strength of an individual's social network, hence underestimating its effect. Finally, our ability to extrapolate the impact of social networks on engagement with the healthcare system and other health behaviors aside from alcohol and tobacco use is limited.

Despite these limitations, we are uniquely positioned to understand the impact of social factors on life expectancy due to several factors. First, the study's comprehensive follow up over 25 years and limited censoring with regards to death allow us to robustly approximate life expectancy in over 5000 individuals. Second, clinical data coupled with data collected on social factors allow us to understand the impact of wide-ranging comorbidities on life expectancy including some which have not been formally assessed in other analyses (e.g.,

frailty). Third, we routinely and systematically collected data on ADLs, enabling us to test not on the quantity but also the quality of life experienced by these participants.

CONCLUSION

In older adults, higher social networks scores are independently associated with higher life expectancy and disability-free life expectancy in a linear dose response despite controlling for age, race, sex, and comorbidity burden. How best to apply these results to improve the breadth and strength of social networks in older adults, and thereby to translate this finding into longer and healthier lives for older adults, will require future study.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

FUNDING:

This research was supported by contracts HHSN268201200036C, HHSN268200800007C, HHSN268201800001C, N01HC55222, N01HC85079, N01HC85080, N01HC85081, N01HC85082, N01HC85083, N01HC85086, and grants U01HL080295 and U01HL130114 from the National Heart, Lung, and Blood Institute (NHLBI), with additional contribution from the National Institute of Neurological Disorders and Stroke (NINDS). Additional support was provided by R01AG023629 and K24AG065525 from the National Institute on Aging (NIA). A full list of principal CHS investigators and institutions can be found at CHS-NHLBI.org.

The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

REFERENCES:

1. Berkman LF. Assessing the physical health effects of social networks and social support. Annu Rev Public Health 1984;5:413–432. [PubMed: 6372817]
2. Berkman LF, Syme SL. Social networks, host resistance, and mortality: a nine-year follow-up study of Alameda County residents. Am J Epidemiol 1979;109(2):186–204. [PubMed: 425958]
3. Seeman TE, Berkman LF, Blazer D, Rowe JW. Social ties and support and neuroendocrine function: The MacArthur studies of successful aging. Annals of Behavioral Medicine 1994;16(2):95–106.
4. Brummett BH, Barefoot JC, Siegler IC, et al. Characteristics of socially isolated patients with coronary artery disease who are at elevated risk for mortality. Psychosom Med 2001;63(2):267–272. [PubMed: 11292274]
5. Barefoot JC, Gronbaek M, Jensen G, Schnohr P, Prescott E. Social network diversity and risks of ischemic heart disease and total mortality: findings from the Copenhagen City Heart Study. Am J Epidemiol 2005;161(10):960–967. [PubMed: 15870160]
6. Bosworth HB, Schaie KW. The relationship of social environment, social networks, and health outcomes in the Seattle Longitudinal Study: two analytical approaches. J Gerontol B Psychol Sci Soc Sci 1997;52(5):P197–205. [PubMed: 9310088]
7. HOUSE JS, ROBBINS C, METZNER HL. THE ASSOCIATION OF SOCIAL RELATIONSHIPS AND ACTIVITIES WITH MORTALITY: PROSPECTIVE EVIDENCE FROM THE TECUMSEH COMMUNITY HEALTH STUDY. American Journal of Epidemiology 1982;116(1):123–140. [PubMed: 7102648]
8. Olsen RB, Olsen J, Gunner-Svensson F, Waldstrøm B. Social networks and longevity. A 14 year follow-up study among elderly in Denmark. Social science & medicine 1991;33(10):1189–1195. [PubMed: 1767289]
9. Holt-Lunstad J, Smith TB, Layton JB. Social relationships and mortality risk: a meta-analytic review. PLoS Med 2010;7(7):e1000316. [PubMed: 20668659]

10. Schoenbach VJ, Kaplan BH, Fredman L, Kleinbaum DG. Social ties and mortality in Evans County, Georgia. American journal of epidemiology 1986;123(4):577–591. [PubMed: 3953538]
11. Kaplan GA, Salonen JT, Cohen RD, Brand RJ, Leonard Syme S, Puska P. Social connections and mortality from all causes and from cardiovascular disease: prospective evidence from eastern Finland. American journal of epidemiology 1988;128(2):370–380. [PubMed: 3394703]
12. Orth-Gomer K, Johnson JV. Social network interaction and mortality: a six year follow-up study of a random sample of the Swedish population. Journal of chronic diseases 1987;40(10):949–957. [PubMed: 3611293]
13. Hanson BS. Social network, social support and heavy drinking in elderly men-a population study of men born in 1914, Malmö, Sweden. Addiction 1994;89(6):725–732. [PubMed: 8069173]
14. Welin L, Svärdsudd K, Ander-Peciva S, et al. Prospective study of social influences on mortality: the study of men born in 1913 and 1923. The Lancet 1985;325(8434):915–918.
15. Holt-Lunstad J, Smith TB, Baker M, Harris T, Stephenson D. Loneliness and social isolation as risk factors for mortality: a meta-analytic review. Perspect Psychol Sci 2015;10(2):227–237. [PubMed: 25910392]
16. Escobar-Bravo MA, Puga-Gonzalez D, Martin-Baranera M. Protective effects of social networks on disability among older adults in Spain. Arch Gerontol Geriatr 2012;54(1):109–116. [PubMed: 21353317]
17. Avlund K, Lund R, Holstein BE, Due P. Social relations as determinant of onset of disability in aging. Arch Gerontol Geriatr 2004;38(1):85–99. [PubMed: 14599708]
18. Jacob ME, Yee LM, Diehr PH, et al. Can a Healthy Lifestyle Compress the Disabled Period in Older Adults? J Am Geriatr Soc 2016;64(10):1952–1961. [PubMed: 27603679]
19. Fried LP, Borhani NO, Enright P, et al. The Cardiovascular Health Study: design and rationale. Ann Epidemiol 1991;1(3):263–276. [PubMed: 1669507]
20. Lubben JE. Assessing social networks among elderly populations. Family & Community Health: The Journal of Health Promotion & Maintenance 1988;11(3): 42–52.
21. Cohen SMR, Kamarck T, Hoberman HM Measuring the functional components of social support Vol vol 24: Springer, Dordrecht; 1985.
22. Diehr P, Diehr M, Arnold A, et al. Predicting Future Years of Life, Health, and Functional Ability: A Healthy Life Calculator for Older Adults. Gerontol Geriatr Med 2015;1:2333721415605989. [PubMed: 28138467]
23. Longstreth WT Jr., Diehr PH, Yee LM, Newman AB, Beauchamp NJ. Brain imaging findings in elderly adults and years of life, healthy life, and able life over the ensuing 16 years: the Cardiovascular Health Study. J Am Geriatr Soc 2014;62(10):1838–1843. [PubMed: 25333525]
24. Govindarajulu US, Spiegelman D, Thurston SW, Ganguli B, Eisen EA. Comparing smoothing techniques in Cox models for exposure-response relationships. Stat Med 2007;26(20):3735–3752. [PubMed: 17538974]
25. Ives DG, Fitzpatrick AL, Bild DE, et al. Surveillance and ascertainment of cardiovascular events. The Cardiovascular Health Study. Ann Epidemiol 1995;5(4):278–285. [PubMed: 8520709]
26. Olshansky SJ, Antonucci T, Berkman L, et al. Differences in life expectancy due to race and educational differences are widening, and many may not catch up. Health affairs 2012;31(8):1803–1813. [PubMed: 22869659]
27. Hoogendijk EO, Suanet B, Dent E, Deeg DJ, Aartsen MJ. Adverse effects of frailty on social functioning in older adults: Results from the Longitudinal Aging Study Amsterdam. Maturitas 2016;83:45–50. [PubMed: 26428078]
28. Fried LP, Tangen CM, Walston J, et al. Frailty in older adults: evidence for a phenotype. J Gerontol A Biol Sci Med Sci 2001;56(3):M146–156. [PubMed: 11253156]
29. Smith KP, Christakis NA. Social Networks and Health. Annual Review of Sociology 2008;34(1):405–429.
30. Cacioppo JTHL, Berntson GG. :. The anatomy of loneliness. Current Directions in Psychological Science 2003(12):71–74.
31. Cohen S, Janicki-Deverts D. Can We Improve Our Physical Health by Altering Our Social Networks? Perspect Psychol Sci 2009;4(4):375–378. [PubMed: 20161087]

Table 1:

Baseline Characteristics of CHS participants stratified by social network score in tertiles (n=5,749)

	Tertile 1 (0–29.99) (n=1875)	**Tertile 2 (30.00–35.87) (n=1942)**	**Tertile 3 (35.88–50) (n=1932)**
Female	59%	57%	57%
White	79%	85%	87%
Age (years)	74 (6.1)	73 (5.3)	72 (5.0)
BMI (kg/m^2)	26 (4.8)	27 (4.8)	27 (4.5)
Ever smoker	54%	54%	52%
Current alcohol use	48%	51%	51%
Married	45%	72%	82%
> High School Education	41%	45%	45%
Annual Income			
$ 0- $11,999	37%	24%	19%
$ 12,000- $24,999	33%	35%	37%
> $25,000	30%	41%	44%
Comorbidities			
Coronary Heart Disease	19%	20%	20%
Congestive heart failure	5%	5%	4%
Diabetes	17%	16%	16%
HTN	46%	45%	43%
Stroke	5%	4%	4%
CES-D score	5.6 (4.9)	4.6 (4.5)	3.9 (4.1)
DSST score	34.4 (13.7)	36.7 (13.2)	38.1 (13.3)

Values shown as % or mean (SD)

TABLE 2:

Adjusted Estimates of Years of Life (YOL) per Social Network Score at Baseline and Averaged over Two Years (N=5,749)

	Social Network Score per SD [95%CI; p-value]	Social Network Score in Tertiles (compared to first tertile) [95% CI; p-value]		
		Tertile 1	Tertile 2	Tertile 3
Baseline Adjusted Model	0.33 [0.15–0.51; p=0.003]	0 [Referent]	0.47 [0.16–0.75; p=0.004]	0.55 [0.40–1.10; p=0.04]
Averaged Adjusted model	0.40 [0.22–0.58; p<0.001]	0 [Referent]	0.54 [0.13–0.95; p=0.01]	0.75 [0.47–1.27; p<0.001]
Averaged model with additional adjustment for Social support	0.39 [0.18–0.59; p<0.001]	0 [Referent]	0.48 [0.05–0.91; p=0.03]	0.67 [0.19–1.14; p=0.005]
Averaged model with additional adjustment for frailty	0.40 [0.21–0.59; p<0.001]	0 [Referent]	0.55 [0.11–0.98 p=0.01]	0.80 [0.34–1.26; p<0.001]

All models adjusted for participant age, race, gender, income, education, marital status, field center (from which CHS participants were recruited), smoking, alcohol use, digital symbol substitution score, depression score (CES-D), BMI, clinical cardiovascular disease (congestive heart failure, coronary heart disease, peripheral arterial disease), hypertension, stroke, and diabetes. Additional adjustment as per above. The baseline model used baseline values for social network and social support scores (at study enrollment) while the average adjusted model used averaged values for both scores over two consecutive years.

Table 3:

Linear Regression Estimates for Years of Active Life and Compression of Disability per Social Network score (n=5,749)

	Social Network Score per SD [95%CI; p-value]	Social Network Score in Tertiles (compared to first tertile) [95% CI; p-value]		
		Tertile 1	Tertile 2	Tertile 3
Years of Active Life				
Baseline model	0.28 [0.11–0.47; p=0.002]	0 [Referent]	0.44 [0.08–0.89; p=0.03]	0.54 [0.18–0.90; p=0.002]
Averaged adjusted model	0.35 [0.18–0.53; p<0.001]	0 [Referent]	0.53 [0.13–0.94; p<0.001]	0.68 [0.26–1.10; p=0.002]
Compression of Disability				
Average Adjusted model	0.009 [0.002–0.01; p=0.06]	0 [Referent]	0.011 [−0.003–0.026; p=0.13]	0.013 [−0.002–0.029; p=0.09]

Model adjusted for participant age, race, gender, income, education, marital status, field center (from which CHS participants were recruited), smoking, alcohol use, digital symbol substitution score, depression score (CES-D), BMI, clinical cardiovascular disease (congestive heart failure, coronary heart disease, peripheral arterial disease), hypertension, stroke, and diabetes. The baseline model used baseline values for social network and social support scores (at study enrollment) while the average adjusted model used averaged values for both scores over two consecutive years.