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Social contact frequency and all-cause mortality: A meta-analysis and meta-regression

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ABSTRACT

Social contact frequency is a well-defined and relatively objective measure of social relationships, which according to many studies is closely associated with health and longevity. However, no previous meta-analysis has isolated this measure; existing reviews instead aggregate social contact with other diverse measures of social support, leaving unexplored the unique contribution of social contact to mortality. Furthermore, no study has sufficiently explored the factors that may moderate the relationship between contact frequency and mortality. We conducted meta-analyses and meta-regressions to examine 187 all-cause mortality risk estimates from 91 publications, providing data on about 400,000 persons. The mean hazard ratio (HR) for mortality among those with lower levels of social contact frequency was 1.13 ($p < 0.05$) among multivariate-adjusted HRs. However, sub-group meta-analyses show that there is no significant relationship between contact and mortality for male individuals and that contact with family members does not have a significant effect. The moderate effect sizes and the lack of association for some subgroups suggest that mere social contact frequency may not be as beneficial to one's health as previously thought.

1. Introduction

Over the last three decades, a growing number of studies have documented the association between social relationships and various health and longevity outcomes. Social interactions with others have been linked to improved mental health (Dalgard et al., 1995; Dressler, 1985; Mathiesen et al., 1999); to lower susceptibility to cancer (Ell et al., 1992; Hibbard and Pope, 1993; Welin et al., 1992), infectious diseases (Cohen, 1991; Lee and Rotheram-Borus, 2001; Patterson et al., 1996) and cardiovascular diseases (Johnson and Hall, 1988; Lepore et al., 1993; Roy et al., 1998); and to lower overall and cause-specific mortality rates (Andre-Petersson et al., 2006; Berkman et al., 1992; Brummett et al., 2005; Hanson et al., 1989; Lyyra and Heikkinen, 2006; Zhang et al., 2007).

The literature offers three main explanations for why social relationships may have a positive association with health outcomes. First, some argue that relationships moderate the adverse health effects of stress and loneliness by enhancing emotional support, intimacy, attachment, and feelings of self-worth, self-competence and emotional well-being, as well as providing comfort in times of need (Barrera, 2000; Berkman et al., 2000; House, 2001; Uchino, 2006; Umberson et al., 2010; Umberson and Montez, 2010). Second, relationships can facilitate healthy behaviors, such as adherence to medical treatment regimes, exercise, keeping a healthy diet, and smoking cessation (Kaplan et al., 1994; Uchino, 2004, 2006; Uchino et al., 1996). This may occur through various cognitive mechanisms. For example, contacts may actively pressure individuals to regulate their behaviors, or they may provide individuals with cognitive information about more healthy practices that would then more indirectly increase the chances for behavioral change (Cohen, 2004; Lyyra and Heikkinen, 2006). Finally, relationships can also be associated with a greater availability of instrumental assistance and material help, which may be especially crucial for the elderly and those suffering from mobility limitations (Messeri et al., 1993; Thoits, 2011). These different forms of support may be crucial at varying stages of the life course (for example, information on health behaviors may be more important at younger ages, while instrumental physical assistance may be especially important at older ages).

In the present study we focus on one particular aspect of social relationships – *social contact frequency*, defined as the frequency of social interactions with others. Social contact frequency is a

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relatively objective measure, unlike subjective measures of social relationships such as *perceptions* of social support. Social contact frequency focuses on the quantity of interactions one has, rather than the individual's assessment of the support he or she receives from others. Both “subjective” and “objective” measures of social relationships have strengths and weaknesses. Objective measures fail to penetrate the deeper meaning of social relationships and the way these are perceived and experienced. For example, people may not always judge higher proximity or contact with others as positive, especially when they consider this contact stressful or overbearing. Indeed, studies on negative social exchange suggest that some relationships are perceived as a burden rather than a source of support and enjoyment. This may be true when the relationship is perceived as too demanding, insensitive and invasive, or when those with whom one is in contact suffer from serious problems of their own (Edwards et al., 2001; Ruehlman and Karoly, 1991).

While these drawbacks might suggest preferring subjective measures, such measures are not without their shortcomings. Perhaps most importantly, subjective assessments of support suffer from idiosyncrasy and differential perceptions. Research has found, for example, that subjective perceptions of social support may be influenced by one's personality, mood, or cultural upbringing (Lakey et al., 1996; Pierce et al., 1992; Procidano and Heller, 1983; Russell et al., 1997; Sarason et al., 1991; Shor and Simchai, 2009). Hence, one person's definition of “high” social support at a given time may not be shared by other people, or even by the same person at a different time. This renders comparisons between individuals less reliable. Furthermore, studies have found that “supportive” social ties can sometimes encourage risky and unhealthy behaviors such as cigarette smoking, drug use, and reckless driving (Burg and Seeman, 1994; Uchino, 2006; Wills and Yaeger, 2003).

The scope of the combined literatures on subjective and objective measures of social relationships precludes a detailed analysis of each within the same paper. We therefore chose to focus solely on social contact frequency in the present analysis, seeking to present depth rather than breadth. Social contact frequency is also a direct and relatively precise measure. Other frequently used variables, such as marital status or engagement in out-of-the-house activities, do not necessarily capture the actual frequency of social interactions. Social contact frequency, on the other hand, is arguably the most direct and therefore accurate measure for the frequency of such interactions.

Our study is important for two main reasons. First, while the majority of existing studies report a positive association between social contact frequency and longevity (e.g. Berkman et al., 1992; Berkman et al. 2004; Okamoto and Tanaka, 2004; Rozzini et al., 1991), a large portion of the studies we surveyed found no significant effect or a negative effect, in particular after controlling for various demographic and behavioral factors (Bagiella et al., 2005; Krause, 1997; Thong et al., 2007; Yeager et al., 2006). We thus wish to explore whether the association remains significant even when accounting for other important explanatory factors.

Second, according to many of the field's leading scholars (e.g. Uchino, 2009; Umberson et al., 2010), the most pressing task in studying the association of social relationships and health today is identifying and elucidating how relationships affect health and mortality. In other words, it is essential to continue exploring the mediating and moderating factors (the “black box”) in this association. This process of understanding intervening mechanisms and the relative impact of each of these mechanisms on health outcomes is essential for designing effective interventions (Gottlieb, 2000; Seeman, 1996; Thoits, 1995, 2011). We therefore focus in the present study on the moderators of the social contact frequency-health association. Meta-analysis and meta-regression methods are especially useful for identifying social contact frequency moderators. For example, differences in cultural norms and quality of medical care may imply geographical heterogeneity in the social contact frequency-health association. As most studies typically focus on a single geographic locale, comparisons between studies may be better suited for the analysis of this type of heterogeneity. We use meta-analysis and meta-regression methods for the examination of this and other similar types of heterogeneity because they allow us to leverage recurring differences between the sampling frames already examined in a large range of existing studies. This analysis tactic allows for direct tests of multiple potential mediating and moderating factors.

A small number of meta-analytic reviews have already been conducted in the social relationship literature, but none of them has isolated social contact frequency. Of particular relevance in the context of the present study is the meta-analysis of Holt-Lunstad et al. (2010), who examined associations between mortality outcomes and various social relationship measures (looking predominantly at point estimates from models with the fewest statistical controls). While Holt-Lunstad and colleagues did not include a direct measure for social contact frequency in their analysis, they did report findings for similar measures: Social isolation (inversed) (OR, 1.40; 95% CI, 1.06–1.86), social networks (OR, 1.45; 95% CI, 1.32–1.59), and social integration (OR, 1.52; 95% CI, 1.36–1.69). While this analysis makes important contributions, the precise measurement of each of these three concepts remains somewhat vague and none of them directly captures social contact frequency. Furthermore, the analysis does not differentiate between unadjusted and better-controlled models and does not investigate the potential moderators of the social contact frequency–mortality relationship.

The present study thus offers an important addition to our understanding by examining the heterogeneity in the contact-mortality association stemming from differences in the identity of those with whom one has contact (family vs. friends vs. others) and the sex, age, health status, and geographic location of the individuals in the study. We outline below the theoretical relevance of these factors and the hypotheses associated with each.

Source of contact: The literature on social relationships often suggests that a relationship with family members and friends may have different consequences, both in terms of how this relationship is perceived (Crohan and Antonucci, 1989; Rook, 1987; Seeman and Berkman, 1988) and in terms of its mental-health and physiological-health outcomes (Gallant et al., 2007; Matt and Dean, 1993; Potts, 1997). This literature suggests that it is through one's close relationships that one receives the greatest quantity of emotional aid, small services, and companionship (Wellman and Wortley, 1990). In addition, the bulk of frequent contact (especially at older ages) often occurs with a relatively limited number of close individuals who are frequently family members (Wellman and Frank, 2001; Wellman and Wortley, 1990).

Some scholars have suggested that contact with friends may be especially important, as friendships tend to be highly reciprocal (Wenger, 1990) and provide greater emotional support (Lee and Ishii-Kuntz, 1987). According to Thoits (2011), in times of acute stress those who are very close to the individual (such as family members) may be too emotionally invested in the person's recovery or even at times experience the person's stressor themselves. Friends, on the other hand, typically share similar characteristics and values, and hence provide emotional and informational support more tailored to the specific problem at hand (Miller and Darlington, 2002). Other scholars, however, have argued that family members (especially siblings, children, and spouses; see Wellman and Wortley, 1989; Wellman and Wortley, 1990) are more important for providing instrumental support (e.g. financial aid), assisting with practical tasks and physical needs, and providing help during periods of illness. If that is indeed the case, we may expect the protective health effects of contact with family members to be greater than those of contact with friends, which in turn should be greater than the effects of contact with more remote individuals.

Sex: Some previous studies suggested that there are sex differences in the positive health effects of social relationships, with males enjoying these effects more than females. This difference may be due to the fact that females often enjoy a wider range of social contacts than do males (Fuhrer et al., 1999b), thus making any additional support more significant for males. Indeed, positive effects of social relationships were often found to be stronger for males than for females (House et al., 1982; Kaplan et al., 1988; Wilkins, 2003), though the opposite has also been reported (Lyyra and Heikkinen, 2006).

Age: the majority of studies on social contact frequency and mortality focus on older-age persons (e.g. Baumann et al., 1998; Bryant and Rakowski, 1992; Cerhan and Wallace, 1997; Rodriguez-Laso et al., 2007). The (often implicit) assumption behind this choice is that the benefits of social contacts are especially pronounced in older populations. This could be because older people are more likely to suffer from loneliness and lack of intimacy, and therefore have more to gain from contact with others. We test this assumption and assess whether social support is indeed more beneficial for the elderly.

Cultural and geographic differences: Finally, cultural and geographic differences may also moderate the social contact-mortality association. For example, a lack of social contact may have a greater effect on people's health and longevity in more traditional cultures (e.g. in East Asian countries), where close family relations often persist to older ages (Mason, 1992). One may therefore hypothesize that those with little social contact will experience more adverse health outcomes in places where the norms of family-provided support are strongest. For another example, support from friends and family members may be especially important in places where institutional state assistance is weaker (as is the case in the United States compared with other developed nations). One may therefore expect that the negative consequences of low social contact will be exacerbated in places where there are relatively few substitutes for the benefits that tight-knit social bonds often provide.

2. Materials and methods

2.1. Search strategy and coding procedures

In June 2005 we conducted a search of electronic bibliographic databases to retrieve all publications related to psychosocial stress and all-cause mortality or social isolation (including measures of social contact frequency) and all-cause mortality. We used 100 search clauses for Medline, 97 for EMBASE, 81 for CINAHL, and 20 for Web of Science (information on the search algorithms is available from authors upon request). Using this search as our base, we then iteratively searched (1) the bibliographies of eligible publications; (2) the lists of sources citing an eligible publication; and (3) the sources identified as "similar to" an eligible publication. We also consulted with experts in the field and conducted additional searches for unpublished dissertations and other unpublished work. We conducted 5 search and coding iterations: in each we coded all publications deemed eligible in the previous round of searches and then used these publications as the base for additional searches. In each of these following coding iterations, we searched both the bibliographies of the publications from the previous coding iteration and publications that cited these articles or were considered "similar" to these articles by Google Scholar and Web of Science search engines. We exhausted the literature search and coding stages in January 2009, after 3.5 years of coding (for more details on these procedures see Roelfs et al., 2010, 2011a, 2013).

The two lead authors independently determined publication eligibility and extracted the data from the articles. Data were jointly coded and publications were tracked throughout the process using basic spreadsheets (See Appendix for full list of variables for which data were sought). Any unpublished work encountered was considered for study inclusion. Although our search was done in English, we were able to locate and translate the relevant portions of eight publications written in German, Danish, or Spanish. Fig. 1 summarizes the number of publications considered at each step of the search process. The full database contained 752 publications examining the between various measures of social relationships and all-cause mortality. To evaluate coding accuracy we randomly selected and recoded 25 of these publications (153 point estimates) and found no coding errors.

2.2. Inclusion criteria and sample

Studies were eligible for inclusion in the meta-analysis and meta-regression if they (1) clearly compared a group of people who had a lower frequency of self-reported social contact frequency (or no contact at all) and another group who had a higher rate of contact; (2) had all-cause mortality as the outcome of interest, reported a measure of statistical significance (see below); and (3) reported a hazard ratio (or provided information sufficient to convert the results to hazard ratio format). In order to focus on the unique effects of social contact frequency, other measures of social relationships, such as marital status, having children, network size, frequency of participation in social and religious activities, and perceived level of social support were all excluded from the present analysis (see Fig. 1 for additional details on the inclusion procedure). Elsewhere, however, we examine in detail the association between marital status and mortality (Roelfs et al., 2011b; Shor et al., 2012a,b), and between social participation (Shor and Roelfs, 2013) and self-reported social support (Shor et al. 2013) and mortality.

These inclusion and exclusion criteria resulted in a subset of 91 publications (all in English and appearing in peer-reviewed journals) included in the present analysis. These publications provided 187 point estimates (hazard ratios) for analysis. Most of the measures included in the analysis (87.2%) focused directly on the frequency of respondents' association with family members, friends, and others. We looked at measures such as the frequency of visits by close friends and family members, time spent in face-to-face talks with co-workers, neighbors, friends and family, and the frequency of phone contact with family members and friends. In addition, we included in our analyses some measures that combined the frequency of contact with other measures of social relationships, such as marital status and living arrangements (these constituted 12.8% of the measures included in our study). However, we made sure to flag these more heterogeneous measures and compared the analyses that included them to those that looked exclusively at contact frequency (see the results section below for a report on the differences between these analyses). Table 1 provides additional details on the full set of studies included in our analysis.

2.3. Methods

Statistical methods varied from study to study, necessitating the conversion of odds ratios, rate ratios, standardized mortality ratios, relative risks, and hazard ratios (HRs) into a common metric. All non-hazard-ratio point estimates were converted to hazard ratios (the most frequently reported type). We used the standard errors reported in the publications to calculate the inverse variance

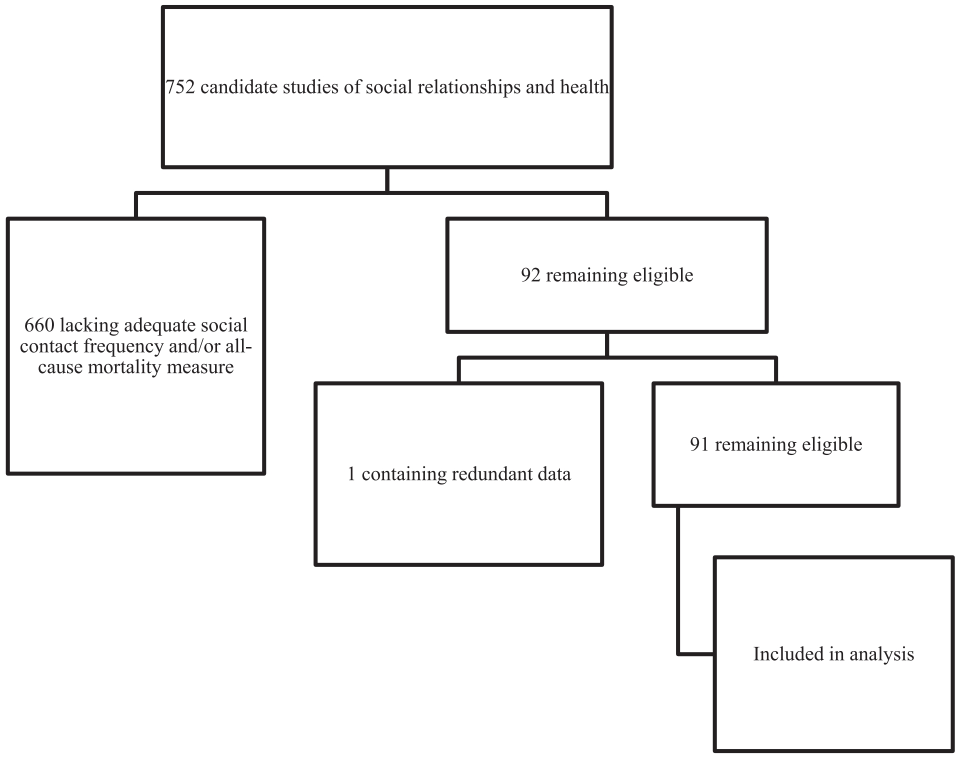


Fig. 1. Study inclusion/exclusion flow diagram.

weights. When not reported, standard errors were calculated using (1) confidence intervals, (2) *t* statistics, (3) χ^2 statistics, (4) exact p-values, or (5) the midpoint of the p-value range.

We adopted two measures of study quality. First, we assigned a 3-level subjective rating to each publication (individual study ratings are available upon request). We rated publications as "low quality" if they contained obvious reporting or methodological errors. Publications were rated as high quality if models were well-specified and results were reported in detail. Second, we used principal components factor analysis to construct a scale measure (continuous, range = 0–10) using (1) the 5-year impact factor (ISI Web of Knowledge, 2009) of the journal in which the article was published (missing values assigned a factor of 1); and (2) the number of citations received per year since publication according to ISI Web of Knowledge. The Spearman correlation between the subjective rating and the factor-analysis-derived rating was low (rho = 0.296; p < 0.001), indicating that these two measures tap different dimensions of quality.

Both *Q*-tests and I^2 tests were used to assess the presence and magnitude of heterogeneity in the data (Huedo-Medina et al., 2006). All analyses were calculated by maximum likelihood using a random effects model and matrix macros provided by Lipsey and Wilson (2001). The danger of selection bias was examined using a funnel plot of the log HRs against sample size. Funnel plot asymmetry was tested using Egger's test (Egger and Davey-Smith, 1998).

The following covariates were used in these analyses: (1) source of support[1]; (2) degree of support deficiency (no contact at all or low contact frequency in the comparison group); (3) preexisting health condition; (4) proportion of respondents who were male; (5) mean age of sample at baseline, divided by 10; (6) age of the study (years elapsed since the collection of baseline data), divided by 10; (7) geographic region[2] (8) sample size, log transformed; (9) a series of variables indicating the level of statistical adjustment; (10) subjective quality rating (range = 1–3); and (11) the composite scale of study quality.

3. Results

Table 2 provides descriptive statistics on the 187 mortality risk estimates included in this study (providing data on about 400,000 persons). We obtained data from 91 studies published between 1979 and 2008, covering 17 countries from North America, Europe, and East Asia (see full details on all 17 countries in the table). Both males and females are well-represented in the dataset, as are various age groups, especially above the age of 40. The age range for the sample was 25–93, with a mean age of 68.18. The median of studies' maximum follow-up duration was 8.09 years. Of the HRs analyzed, 99% came from studies assigned a quality rating of 2 (moderate) or 3 (high).

Table 3 presents the results of a number of meta-analyses, in addition to sample size and heterogeneity information (analyses are stratified by the level of statistical adjustment of the risk estimate). Persons with lower contact levels had a significantly higher risk of death compared to those with higher support levels. However, there is a large drop in risk when focusing on models adjusted for multiple variables (which are calculated on a sub-sample of 70 of the 91 publications, those which included adjusted models). While the mean unadjusted HR was 1.62 (95% Confidence Interval [CI]: 1.46, 1.80; n = 35 HRs), the mean HR among point estimates adjusted for multiple covariates was only 1.13 (95% CI: 1.09, 1.17; n = 151 HRs). In other words, greater social contact is beneficial, but

[1] The three categories of this variable are (1) family members (including both family of origin and family of procreation), (2) friends, and (3) other people/, as they were defined in the relevant articles from which data were extracted.

[2] The five categories of this variable (based on cultural affinity and similarities in healthcare systems) are: (1) the United States; (2) Scandinavia; (3) Canada and the UK; (4) Continental Europe; and (5) East Asia. Table 2 provides further details on the specific countries included in each sub-region.

Table 1
Summary information for studies included in the analysis.

Authors	Country	Study years	Number of HRs used	Sample size
Astone et al. (2002)	United States	1967–1998	1	1136
Avlund et al. (1998)	Denmark	1984–1995	2	734
Bagiella et al. (2005)	United States	1981–2002	2	14,456
Barefoot et al. (2005)	Denmark	1991–1997	4	9573
Baumann et al. (1998)	Germany	1989–1995	1	1987
Berkman and Syme (1979)	United States	1965–1974	6	6928
Berkman et al. (1992)	United States	1982–1989	1	194
Berkman et al. (2004)	France	1991–1999	2	16,699
Bowling (1994)	United Kingdom	1979–1992	1	505
Bowling and Charlton (1987)	United Kingdom	1979–1985	3	380
Bryant and Rakowski (1992)	United States	1984–1988	4	473
Bygren et al. (1996)	Sweden	1982–1991	1	12,675
Cerhan and Wallace (1997)	United States	1982–1993	2	2575
Ceria et al. (2001)	United States	1991–1997	1	3497
Eng et al. (2002)	United States	1986–1998	2	28,369
Falk et al. (1992)	Sweden	1982–1989	1	500
Forster and Stoller (1992)	United States	1982–1989	2	363
Fry and Debats (2006)	Canada	1996–2002	2	380
Fuhrer et al. (1999a)	France	1988–1994	2	3777
Goldman et al. (1995)	United States	1984–1990	2	7478
Goodwin et al. (1996)	United States	1984–1994	2	646
Grand et al. (1990)	France	1982–1987	1	645
Greenfield et al. (2002)	United States	1984–1995	2	5177
Greenwood et al. (1995)	United Kingdom	1986–1993	1	1283
Grundy et al. (1996)	United Kingdom	1986–1993	2	618
Guilley et al. (2005)	Switzerland	1994–1999	1	295
Gustafsson et al. (1998)	Sweden	1986–1995	2	421
Hanson et al. (1989)	Sweden	1982–1987	1	500
Harris and Thoresen (2005)	United States	1984–1991	2	7496
Helweg-Larsen et al. (2003)	Denmark	1987–1999	1	6693
Ho (1991)	China	1985–1988	1	1054
House et al. (1982)	United States	1967–1979	2	2754
Iribarren et al. (2005)	United States	1985–2000	1	5115
Iwasaki et al. (2002)	Japan	1993–2000	4	11,565
Jenkinson et al. (1993)	United Kingdom	1986–1990	1	1376
Jylha and Aro (1989)	Finland	1979–1985	4	1060
Kaplan et al. (1988)	Finland	1972–1985	1	13,301
Kaplan et al. (1994)	Finland	1986–1992	1	2503
Kawachi et al. (1996)	United States	1988–1992	1	32,624
Kiely and Flacker (2003)	United States	1994–1998	1	30,070
Kiely et al. (2000)	United States	1994–1998	1	927
Kotler and Wingard (1989)	United States	1965–1982	3	3188
Krause (1997)	United Kingdom	1984–1995	2	2349
Kroenke et al. (2006)	United States	1992–2004	1	2835
LaVeist et al. (1997)	United States	1984–1989	1	726
Lennartsson and Silverstein (2001)	Sweden	1992–1996	2	463
Litwin (2007)	Israel	1997–2004	7	1811
Litwin and Shiovitz-Ezra (2006)	Israel	1997–2004	3	5055
Lund et al. (2000)	Denmark	1986–1994	6	911
Maier and Klumb (2006)	Germany	1990–2003	1	473
Meinow et al. (2004)	Sweden	1986–2001	1	421
Mertens et al. (1996)	United States	1989–1993	1	1869
Moen et al. (1989)	United States	1956–1986	1	427
Murberg and Bru (2001)	Norway	1996–1998	1	119
Musick et al. (1999)	United States	1986–1994	1	1211
Musick et al. (2004)	United States	1986–1994	1	3617
Nakanishi and Tatara (2000)	Japan	1992–1997	2	493
Okamoto and Tanaka (2004)	Japan	1995–2001	1	784
Okamoto et al. (2007)	Japan	1995–2001	2	784
Olsen et al. (1991)	Denmark	1972–1987	1	1752
Orth-Gomer and Johnson (1987)	Sweden	1976–1984	1	17,433
Orth-Gomer and Unden (1990)	Sweden	1977–1987	1	150
Orth-Gomer et al. (1986)	Sweden	1976–1981	1	17,364
Parker et al. (1992)	Sweden	1986–1989	2	421
Rasulo et al. (2005)	Denmark	1995–2001	2	2147
Rodriguez-Laso et al. (2007)	Spain	1993–1999	4	1174
Rogers (1996)	United States	1984–1991	2	15,938
Rosengren et al. (1998)	Sweden	1983–1995	1	717
Rosengren et al. (2004)	Sweden	1983–1998	1	741
Roy et al. (1996)	United States	1984–1988	2	805
Rozzini et al. (1991)	Italy	1985–1988	1	1201
Rutledge et al. (2003)	United States	1988–2000	1	7524
Rutledge et al. (2004)	United States	1999–2001	1	503
Sato et al. (2007)	Japan	1992–2004	4	637
Schoenbach et al. (1986)	United States	1967–1980	4	2059
Seeman et al. (1987)	United States	1965–1982	4	4174
Seeman et al. (1993)	United States	1981–1987	6	3809
Shye et al. (1995)	United States	1969–1986	2	455
Steinbach (1992)	United States	1984–1986	1	5151
Strawbridge et al. (2000)	United States	1965–1994	2	5894
Sugisawa et al. (1994)	Japan	1987–1990	1	2200
Thong et al. (2007)	Netherlands	1998–2005	1	528
Vogt et al. (1992)	United States	1970–1986	4	2603
Walter-Ginzburg et al. (2002)	Israel	1989–1997	2	1340
Welin et al. (1985)	Sweden	1973–1982	4	989
Wilkins (2003)	Canada	1994–2001	2	2422
Wingard (1982)	United States	1965–1974	2	4725
Woo (2007)	United States	1998–2002	4	20,568
Yasuda and Ohara (1989)	Japan	1982–1987	4	1889
Yasuda et al. (1997)	United States	1984–1994	6	806
Yeager et al. (2006)	Taiwan	1999–2003	1	3800

Table 2
Descriptive Statistics (n = 187 hazard ratios).

	Minimum	Maximum	Mean/%
Source of contact			
Family			20.3%
Friends, neighbors, and other non-family			21.4%
Multiple sources of contact combined (Reference group)			58.3%
Contact level of lower contact group			
No contact			36.4%
Low contact (reference group)			63.6%
Sex			
Women only			31.0%
Men only			32.1%
Both sexes			36.9%
Mean age of the sample	25	93	68.18
Geographic region			
United States (reference group)			45.5%
Scandinavia (Denmark, Finland, Norway, Sweden)			22.5%
Canada and United Kingdom			7.5%
Continental Europe (France, Germany, Israel, Italy, Netherlands, Spain, Switzerland)			13.9%
East Asia (China, Japan, Taiwan)			10.7%
Study controlled for:			
Age			71.7%
Other demographic factors			20.9%
Socioeconomic status			55.6%
General health status			73.8%
Health behaviors (smoking, drinking, etc.)			50.8%
Chronic conditions			40.6%
Mental health			33.2%
Years elapsed since study baseline	9	52	32.00
Follow-up duration (years)	0.5	32	8.09
Study Quality:			
Coder rating	1	3	2.79
Citation-based scale	0.11	6.87	1.82
Hazard ratio conversion using estimated rates			17.6%
Regression weight estimated			11.2%
Contact measure includes marital status (e.g. Berkman–Syme scale)			12.8%

Table 3
Meta-analyses of the association between social contact frequency and all-cause mortality.[a]

	Unadjusted HRs			Multivariate-adjusted HRs[b]		
	Mean HR	Number of HRs	Q-test p-value[c]	Mean HR	Number of HRs	Q-test p-value[c]
All HRs	1.62***	35	0.0138	1.13***	151	0.0561
Excluding HRs where conversion was done using estimated rate	1.62***	35	0.0107	1.12***	119	0.000
Excluding HRs where weight was estimated	1.67***	33	0.0277	1.14***	132	0.0552
Excluding contact measures that include marital status (e.g. Berkman –Syme scale)	1.52***	26	0.0384	1.11***	136	0.0168
Sex (excluding contact measures that include marital status)						
Female only	1.47***	7	0.5843	1.14**	41	0.0043
Male only	1.51***	14	0.744	1.06	35	0.4886
Source of contact (excluding contact measures that include marital status)						
Family only	1.44	4	0.6018	1.06	32	0.517
Non-family	3.62***	3	0.5368	1.07*	37	0.1577
Multiple sources	1.46***	19	0.1321	1.15***	67	0.0036

[a] Mean hazard ratios reported only when n ≥ 2 hazard ratios.
[b] Covariates vary between studies.
[c] Q-test p-value refers to Cochrane's Q, a measure of heterogeneity among the effect sizes within a group.

its effect is not very large (when compared with the magnitudes of the mean effect sizes reported in previous meta-analyses of social support and social participation, e.g. Holt-Lunstad et al. (2010)). In the present study, there was only a 13% increase in risk for those with lower social contact frequency in studies that control for additional variables.

3.1. Subgroup meta-analyses and meta-regression analyses

Table 4 presents the results of a meta-regression analysis. The table includes two models: the first uses all available HRs in the study (both unadjusted ones and those controlling for multiple variables), while the second only uses the HRs that were adjusted for multiple variables (corresponding more closely with the second column in the meta-analysis table). In the interest of presenting conservative results, from this point forward the discussion of Tables 3 and 4 will focus only on the second column in both – the analyses of HRs adjusted for multiple covariates (constituting over eighty percent of the HRs in our study).

A number of important findings emerge when breaking the analysis into subgroups. First, when we exclude from the analysis publications that relied on aggregate measures of contact (those including a social relationships scale, combining features such as

Table 4
Meta-regression models predicting HR magnitude among studies of social contact frequency and all-cause mortality (lower contact vs. higher contact).[a]

	All HRs	HRs adjusted for multiple covariates
Constant	1.4991 (0.0445)	1.0895 (0.7233)
Contact measure includes marital status (e.g. Berkman–Syme scale)	1.2990 (<.0001)	1.2058 (0.0017)
Source of Contact (Reference group = multiple sources of contact combined)		
Family	0.9560 (0.3216)	0.9255 (0.0666)
Friends, neighbors, and other non-family	0.9541 (0.3070)	0.9163 (0.0406)
Contact level of lower contact group (no contact vs. low contact)	1.0431 (0.2551)	1.0468 (0.2116)
Proportion of sample that is male	0.9388 (0.1481)	0.9440 (0.1797)
Mean age of the sample	0.9996 (0.7953)	1.0014 (0.3809)
Geographic region (reference group = United States)		
Scandinavia (Denmark, Finland, Norway, Sweden)	0.9981 (0.9731)	1.0628 (0.2824)
Canada and United Kingdom	1.0381 (0.5805)	1.0401 (0.5407)
Continental Europe (France, Germany, Israel, Italy, Netherlands, Spain, Switzerland)	1.1846 (0.0076)	1.1470 (0.0249)
East Asia (China, Japan, Taiwan)	1.1129 (0.1145)	1.0652 (0.3230)
Study controlled for:		
Age	0.9561 (0.4891)	1.0478 (0.5491)
Other demographic factors	1.0543 (0.2293)	1.0734 (0.0903)
Socioeconomic status	0.9518 (0.3249)	0.9744 (0.5789)
General health status	0.9532 (0.4389)	1.0074 (0.9134)
Health behaviors (smoking, drinking, etc.)	0.9264 (0.1050)	0.9663 (0.4321)
Chronic conditions	0.9358 (0.0607)	0.9591 (0.2328)
Mental health	0.9457 (0.1948)	0.9770 (0.5577)
Years elapsed since study baseline (divided by 10)	1.0386 (0.3039)	1.0394 (0.2649)
Follow-up duration (years)	0.9959 (0.4407)	0.9978 (0.6691)
Study quality:		
Coder rating	0.9618 (0.4950)	0.9522 (0.4824)
Citation-based scale	1.0233 (0.1504)	1.0124 (0.4410)
Hazard ratio conversion using estimated rates (1 = yes)	0.9120 (0.0662)	0.9721 (0.6030)
Regression weight estimated (1 = yes)	0.9598 (0.4606)	0.9723 (0.6010)

[a] Numbers reported are exponentiated regression coefficients (p-value in parentheses). Exponentiated regression coefficients represent a ratio of a HR at one level on the IV to the HR at the next lowest level. N = 187 hazard ratios for the first model and 151 for the second model. $R^2 = 0.29$ for the first model and 0.18 for the second model.

marital status with social contact frequency measures), the magnitude of the effect further drops to 1.11 (95% CI: 1.07, 1.14; n = 136 HRs). In other words, cleaner measures of social contact frequency lead to an even smaller effect on mortality. Furthermore, the difference in magnitude between these cleaner measures and the more general measures is statistically significant. Table 4 shows that the coefficient for whether a contact measure included marital status is larger than 1 and statistically significant ($p = 0.0017$). That is, the magnitude of the HRs based on social contact frequency indices such as those proposed by Berkman and Syme (i.e., those that include marital status) are significantly higher than the magnitude of HRs that isolate more precise social contact frequency measures.

The meta-analysis results (Table 3) suggest a surprising relationship between the identity of those with whom one has contact and the magnitude of the effect. While we found a significant, but weak, association between contact with non-family (friends and other acquaintances) and longevity (HR = 1.07; 95% CI: 1.01, 1.13), and an even stronger association between contact with multiple sources and longevity, contact with family members does not show a significant association with mortality. The results of our meta-regression analysis show that this difference between contact with family and friends on the one hand and contact with a wider range of people on the other hand is statistically significant at the 0.05 level for friends ($p = 0.0406$) and at the 0.10 for family ($p = 0.0666$). In other words, it appears that the most beneficial contacts one may have are with a wide variety of people (including those often referred to as “weak ties”, which many might think are not as important), rather than only with family or friends.

A second interesting finding in our meta-analysis (Table 3) is that contact appears to be associated with mortality in females, but not in males. That is, while low social contact is associated with a 14% increase in risk for females (HR = 1.14; 95% CI: 1.04, 1.25), the magnitude of the effect is smaller and not significant for males. However, we did not find support for such difference between males and females in our meta-regression analysis (Table 4), as the proportion of the sample that is male was not a significant predictor for the magnitude of the difference.

Similarly, our meta-regression results reveal almost no significant relationships between other sub-group characteristics and the magnitude of the association between contact and mortality. The only exception to this comes from studies conducted in continental Europe, where, compared with the US, the magnitude of the association between contact and mortality was stronger ($p = 0.0076$). Other sub-groups analyses, including age, most geographic regions, and all of the study characteristics (what studies controlled for, when they were done, and their quality) did not reveal statistically significant differences.

3.2. Analysis of data heterogeneity

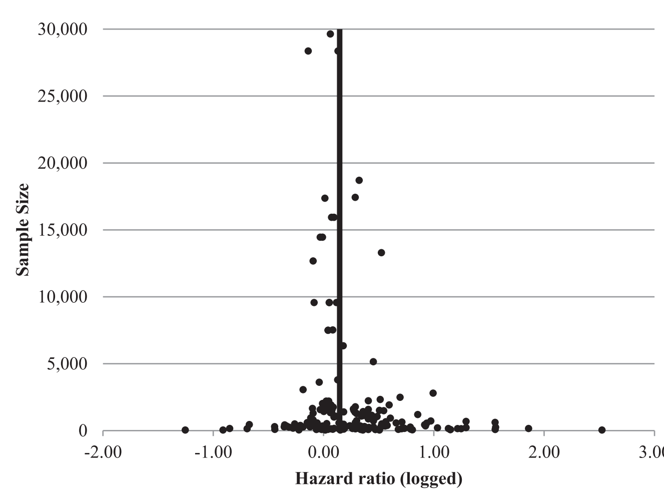
The between-groups Cochrane's Q for the meta-analysis of all 187 HRs was statistically significant ($p < 0.05$), and the unexplained heterogeneity variance component from both meta-regression models was also significant ($p < 0.001$ in both cases), supporting the decision to use random effects models and conduct sub-group meta-analyses. Since the discussion of the meta-analysis focused on HRs adjusted for multiple covariates, we carefully examined the corresponding heterogeneity test results. As shown in Table 3, the Q-tests for these sub-group meta-analyses were statistically significant for two subgroups: the female subgroup ($p = 0.0043$) and the multiple sources of contact subgroup ($p = 0.0036$). I^2 tests for these subgroups indicate heterogeneity was relatively low and in the remaining subgroup analyses, Q-tests and I^2 tests were non-significant. We therefore conclude that the use of a random effects model adequately accounted for heterogeneity.

3.3. Measurements of publication bias

One of the major concerns in meta-analysis research is the tendency of scholars and academic outlets to avoid reporting non-significant findings, otherwise known as “the file drawer effect” (Berman and Parker, 2002; Egger and Davey-Smith, 1998; Rosenthal, 1991). This tendency may lead to an over estimation of the mean HR. Therefore, one should be especially careful in interpreting mean HRs which are relatively close to 1, even when these are significant. Since this is the case in the present analysis, publication bias is indeed a major issue here. Fig. 2 presents a funnel plot of the log HRs against sample size, which appears somewhat asymmetric around the mean, suggesting that there may be some missing publications with a negative or a non-significant relationship (this was confirmed with Egger's test, which showed significant asymmetry, with a p-value < 0.001). However, when applying Rosenthal's (1991) formula for computing the tolerance for null results, it becomes clear that even a very large number of studies with null results would not have been sufficient to render the overall effect of contact on mortality non-significant. Still, the already relatively small magnitude of the effect would have been further decreased if such studies (and, even more, additional studies with a negative association) were published.

4. Conclusion and discussion

We conducted a meta-analysis and meta-regression of the relationship between social contact frequency and all-cause mortality. We found that frequent social contact tends to be associated with greater longevity, but the magnitude of the effect was quite small and not consistent for all subgroups. When considering only HRs adjusted for multiple covariates, the risk of death for people with lower social contact levels was only 13% higher than the risk among those with higher levels of social contact. This relatively small effect becomes even smaller (11%) when excluding measurements from studies in which contact was part of a combined scale, which included additional measures such as marital status or participation in social activities (which may measure different



[1] Vertical line denotes the mean hazard ratio (logged) of 0.1455 among the 187 hazard. P-value from Egger's test for funnel plot assymetry < .001.

Fig. 2. Funnel plot of hazard ratios (logged) vs. sample size.[1]

concepts and processes). Furthermore, the true effect is likely even more modest (although it probably remains significant) when considering the plausible existence of a file drawer effect, where studies with a non-significant effect (or in this case perhaps also a negative effect) may not have been published.

We may therefore conclude that while relatively more frequent social contact is beneficial for one's longevity, the effect may be much more modest than previously thought. One possible reason for this is that contact by itself may not be sufficient. Simply associating with others may not be enough to provide emotional comfort or instrumental assistance or to push an individual to adopt a healthier lifestyle, resulting in greater longevity. It is therefore the type of support that is passed during contact (e.g. contact related to instrumental health vs. contact related to leisure experience) that must be examined more closely. Furthermore, as noted by previous scholars, those with which one has contact may themselves be a source of stress, a burden, or a negative influence. Finally, while contact is likely to decrease feelings of loneliness (which have been associated with decreased mental and physical health, which in turn are associated with higher mortality rates), there is no guarantee that this will indeed be the case. One may have frequent social contact with others, but still feel lonely, especially if these contacts are perceived as superficial and unsatisfying.

A comparison of the very modest magnitude of the effect found in our study to the more substantial one found in another recent meta-analysis of various measures of social relationship and mortality (Holt-Lunstad et al., 2010) highlights the importance of paying closer attention to methodological issues in the study of social contact frequency. Holt-Lunstad and colleagues reported a much higher increase in risk: 40% (for social isolation reversed) to 52% (for social integration). The difference between these results and those of the present study is likely due to differences in inclusion criteria. When possible, Holt-Lunstad and colleagues preferred to include in their study risk estimates that were not adjusted or minimally adjusted for covariates. Conversely, we included in our study both non-adjusted risk estimates and those adjusted for multiple confounders. Nevertheless, we focused in our analysis on the latter, which are the majority of risk estimates and tend to come from newer and better-performed studies. The comparison of our results to those of Holt-Lunstad and colleagues highlights the importance of controlling for confounding explanations when studying the association of social relationships and mortality. Future studies should take pains to control for theoretically important covariates to reduce bias and avoid inflating the magnitude of the effect.

Our meta-regression further offers that the low magnitude of the effect is quite consistent across most of the subgroups we examined, as most of the coefficients in this analysis are not significant. Still, we found a somewhat surprising lack of significant difference between high and low contact with family members. Namely, in studies that control for alternative explanations, more frequent contact with one's family is not associated with greater longevity. This finding stands in contrast to the conventional wisdom among researchers and the wider public that relationships with family members are the ones most important for the individual. One possible explanation for this finding may be that precisely because of the high level of commitment involved, contact with family members may sometimes be a stressor rather than just a source of support. This may especially be the case when one's relatives are sick (and contact means having to take care of them), abusive or overbearing. In these cases, which tend to be more frequent when family members are older, the negative effects of the association may counterbalance the often-reported positive impacts of social relationships. As noted above, studies on negative social exchange indicate that some social relationships may actually add stress to a person's life rather than reduce it. This is especially true when the relationship is too demanding, insensitive and interfering, or if those with whom one is in contact suffer from serious problems of their own, such as physical and mental health problems (Edwards et al., 2001; Ruehlman and Karoly, 1991).

One additional significant difference we report on was in the magnitude of the association between social contact frequency and mortality, which was stronger in continental European countries (France, Germany, Italy, Netherlands, Spain, and Switzerland) than in the US. One possible reason for this difference may be that in most of these countries frequent social contact, even (or especially) at older ages is considered more normative and valued more by both individuals and society at large compared with US society, which is often considered to be more individualistic (Putnam, 2000). If this is indeed the case, then the loss of such contacts may be felt more acutely by individuals who are accustomed to these contacts, or at least have come to expect more of them.

In conclusion, we presented the first meta-analysis to isolate the specific measure of social contact frequency and examine its association with overall mortality. Our results highlight the importance of examining various measures of social relationships separately, rather than treating them all as one and the same. Our findings also show a minimal effect of social contact frequency on all-cause mortality. They therefore call into question intervention programs and clinical advice that simply seek to increase one's social contact frequency. If interventions are to be sought, our findings suggest that it may be preferable to focus attention on increasing the quality of existing contacts, as well as on identifying and reducing contacts that may be producing stress and/or a burden. While we do not propose that the inverse of frequent social contact − lack of social contact − is preferable, our findings do caution that a singular focus on social contact frequency as a determinant of longevity may be somewhat misplaced.

4.1. Limitations

One limitation of our study stems from the nature of the data. Almost all of the research on social contact frequency and mortality was conducted in the developed world (mostly the US and Western Europe, with a small number of publications from Japan, Australia, and Israel). Only one study has looked at a developing nation − China. This fact means that sample sizes in the developing world are too small (or nonexistent) to make any meaningful conclusions about the nature of the relationship in Middle Eastern, East-European, Asian, African, South-American, Caribbean, and Pacific Island nations. Therefore, the findings from the different analyses presented here should not be extrapolated to populations in developing countries.

We also wish to add a word of caution about the measurement of social contact frequency in most of the studies we analyze here: While social contact frequency is a relatively precise and well defined measure (compared for example with more amorphous “social network” scales), there is still a need to differentiate more clearly between various kinds of social contact according to the specific kind of interactions and support that is passed during the contact. For example, it may be that social contact which is mainly emotional in nature produces effects that are different from interactions that are mostly informational. The studies examined here do not allow us to assess whether this is indeed the case, but future studies may pay greater attention to such differentiations.

Appendix. Variables for which data were sought

1) Author names; 2) author genders; 3) publication date; 4) publication title; 5) place of publication; 6) characteristics of low

support group (e.g. never-married persons); 7) characteristics of high support group (e.g. married persons); 8) characteristics shared by both high and low support groups; 9) percent of the sample that was male; 10) minimum and maximum age; 11) mean age; 12) ethnicity; name of data source used; 13) geographic location of study sample; 14) baseline start date (day, month, year); 15) baseline end date (day, month, year); 16) follow-up end date (day month, year); 17) maximum follow-up duration; 18) average follow-up duration; 19) information on timing of support loss relative to baseline start date; 20) information on the structure of the follow-up period (e.g. were there any gaps between the end of baseline and the beginning of follow-up?); 21) statistical technique used; 22) total number of persons analyzed in the publication; 23) total number of persons analyzed for the specific effect size; 24) number of persons in the low support group; 25) number of deaths in the low support group; 26) number of persons in the high support group; 27) number of deaths in the high support group; 28) death rate in the low support group; 29) death rate in the high support group; 30) effect size; 31) confidence interval; 32) standard error; 33) t-statistic; 34) Chi-square statistic; 35) minimum and maximum values for p-value; 36) full list of control variables used; 37) date of data extraction; 38) subjective quality rating; 39) number of citations received by publication according to Web of Science; 40) number of citations received according to Google Scholar; 41) 5-year impact factor for place of publication.

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