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The strength of family ties: A meta-analysis and meta-regression of self-reported social support and mortality

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ABSTRACT

Perceived social support has long been recognized as associated with better health and longevity. However, important factors that may moderate this relationship have not been sufficiently explored. The authors used meta-analyses and meta-regressions to examine 178 all-cause mortality risk estimates from 50 publications, providing data on more than 100,000 persons. The mean hazard ratio (HR) for mortality among those with lower levels of perceived social support was 1.11 (95% confidence interval [CI]: 1.05, 1.17) among multivariate-adjusted HRs. Meta-regressions suggest that support from family members was more beneficial than support provided by friends, and that a moderate level of support may be enough to achieve positive results. The results also show that the importance of having support increases with age. No substantial difference was found between men and women with respect to the relationship between support and mortality.

"An ounce of blood is worth more than a pound of friendship" (Spanish proverb)

Social support typically refers to functions performed for the individual by significant others (Umberson et al., 2010). The literature (e.g., Lin and Westcott, 1991; Umberson and Montez, 2010) identifies three main functions: *Emotional support* involves demonstrations of caring, esteem, encouragement and sympathy and the sense that someone is loved and listened to. *Informational support* refers to the provision of facts or advice which may help an individual solve problems or which guide the individual regarding possible courses of action. Finally, *instrumental support* refers to offering or supplying help for material needs, practical tasks, and everyday problems.

Over the last three decades, a growing number of studies have documented the association between self-reported social support (especially emotional support) and various health and longevity outcomes. Initial research in the 1970s (e.g., Antonovsky (1972), Berkman and Syme (1979), Cassel (1976), Cobb (1976), Hinkle (1973), and Syme (1974)) set the stage for the creation of the theory and empirical analysis of networks, social support, isolation, and social integration and their association with mortality (Berkman, 1986). Support has since been linked to better 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).

Other studies have demonstrated the influence of social relationships on behavioral peer influences such as the consumption of tobacco (Burg and Seeman, 1994), smoking cessation (Christakis and Fowler, 2008) and alcohol consumption (Rosenquist et al., 2010). Other effects of social relationships and networks include obesity (Christakis and Fowler, 2007), weight-loss (Wing and Jeffery, 1999), depression (Rosenquist et al., 2011), loneliness (Cacioppo et al., 2009), stress buffering (Berkman and Glass, 2000; Cohen, 2004), the spread of sexually transmitted or other infectious diseases (Bearman et al., 2004; Laumann and Youm, 1999; Meyers et al., 2003), and health related emotional states, such as optimism, happiness, depression, or suicidality (see review in Smith and Christakis, 2008).

Explanations for why social support is related to health outcomes are diverse. First, some argue that social support (especially emotional) serves as a buffer and moderates the adverse health effects of stress and loneliness by providing active coping assistance and by fostering feelings of intimacy, attachment, control,

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self-worth, self-competence, and emotional sustenance (Barrera, 2000; Berkman et al., 2000; House, 2001; Uchino, 2006; Umberson et al., 2010; Umberson and Montez, 2010). Second, support was found to promote positive health behaviors, including better 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 occurs either by way of actively regulating one's behaviors or by way of providing information about healthy practices (Cohen, 2004; Lyyra and Heikkinen, 2006). Third, research has shown that instrumental social support—for example buying food or providing transportation to medical appointments during periods of illness—may be important in sustaining good health, especially among those who suffer from physical limitations (Bloom, 1990; Dupertuis et al., 2001; Schwarzer and Leppin, 1991).

Additional information on the association between social relationships and health can be found in several prominent reviews (e.g., Barrera, 2000; Berkman and Glass, 2000; Cohen and Syme, 1985; Smith and Christakis, 2008; Thoits, 1995). Such reviews indicate that spouses are the most studied dyad in the context of health and mortality. In particular a large body of research has focused on divorce, widowhood and the hospitalization of a spouse (e.g., Shor et al., 2012a,b; Christakis and Allison, 2006; Christakis and Iwashyna, 2003; Elwert and Christakis, 2008; Subramanian et al., 2008; Zivin and Christakis, 2007).

1. Perceived (subjective) support vs. "objective" measures of support

In the 1980s, research turned to modeling social support through the examination of specific attributes of individuals' social networks (Faber and Wasserman, 2002). A wide variety of network attributes has been used to assess social support, including tie strength, network size, centrality, density, reciprocity, transitivity, proximity and similarity (Faber and Wasserman, 2002; Walker et al., 1993). In their review of the social networks literature, Smith and Christakis (2008) argue that the future of social support research continues to lie in the use of network measures such as these.

Two broad classes of support measures can be discerned from the network attributes listed above: perceived support measures (e.g., strength, reciprocity) and "objective" support measures (e.g., network size, density, proximity). Perceived social support has been defined as "the extent to which an individual believes that his/her needs for support, information, and feedback are fulfilled" (Procidano and Heller, 1983: p. 2), as well as "the level of trust and confidence in the availability of material and intangible assistance from network members" (Uehara, 1990: p. 534). Self-reported, or perceived social support, is often assessed by asking individuals to assess their ability to rely on others, having someone trustworthy to confide in, satisfaction with interactions and companionship, availability and adequacy of emotional ties, and whether they recall receiving tangible instrumental help with daily-life activities (e.g., Andre-Petersson et al., 2006; Berkman et al., 1992; Brummett et al., 2005; Penninx et al., 1997; Saito-Nakaya et al., 2006; Thong et al., 2007).

In contrast, "objective" support refers to the presence of interactions with persons who have the potential of providing social support. Objective support encompasses such diverse measures as participation in specific social or religious groups, counts of various types of members of an individual's social network (e.g., number of friends, children, siblings), and the frequency with which an individual has contact with family and friends. Research on the effect of proximity, for example, has determined that, while proximity affects support generally, emotional and financial aid are often provided effectively over large distances (Walker et al., 1993; Wellman and Wortley, 1990), and through internet and computer supported social networks have been found to be significant social support providers (Hampton and Wellman, 2001, 2003; Wellman and Gulia, 1997). In terms of network size, research has generally found that individuals with larger social networks receive more social support (Faber and Wasserman, 2002), both because of the direct effects of size and because of the diversity of support types (emotional, instrumental, informational) that are likely to be offered (see review in Plickert et al., 2007; Walker et al., 1993).

Both "subjective" and "objective" measures of support have strengths and weaknesses. 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). But objective measures of support have their own drawbacks. O'Reilly (1988: p. 869) points out that counts of network ties and other objective measures often capture multiple support dimensions, including "social participation, social isolation, state of personal well-being, and most often components of social networks". 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). Similarly, studies on negative social exchange suggest that some social relationships may actually add stress to a person's life rather than reduce it, especially if the relationship is too demanding, insensitive and interfering, or if those with whom one is in contact suffer from serious problems of their own (Edwards et al., 2001; Ruehlman and Karoly, 1991).

2. The present study

The present study focuses on the association between perceived social support (instrumental, emotional, and informational) and all-cause mortality. The scope of the combined literatures on subjective and objective measures of support precludes a detailed analysis of each within the same paper. The choice to focus solely on subjective (perceived) support alone is driven by a desire to present depth rather than breadth.

This study is important for two main reasons. First, while the majority of existing studies report a positive effect of perceived social support on longevity (e.g., Berkman et al., 1992; Helmert, 2004; Nakanishi and Tatara, 2000; Walter-Ginzburg et al., 2005), about a third of the studies we surveyed found no significant effect, in particular when controlling for various demographic and behavioral factors (e.g., Gillum et al., 2008; Koenig, 1995; Okamoto et al., 2007; Oxman et al., 1995; Saito-Nakaya et al., 2006). We thus wish to explore whether the association remains significant even when controlling 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 support and health today is identifying and elucidating how social support affects health and mortality. In other words, it is essential to further explore 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). Hence, in the present study we focus on the moderators of the social support-health association.

Both primary studies and meta-analysis methods are useful for testing mediation and moderation hypotheses. However, a number of possible social support moderators are more readily examined using the latter technique. For example, differences in cultural

norms and quality of medical care across time and between nations suggest that the social support-health association may not be geographically or temporally homogenous. While a new long-term multi-site primary study can be designed to test for interactions between social support and time or geographic region on health outcomes, these tests are much more readily accomplished through systematic comparisons of existing studies. Meta-analysis and meta-regression methods allow researchers to leverage recurring differences between the sampling frames already examined in the literature to explore important moderating and mediating factors.

A small number of meta-analytic reviews have already been conducted in the social support literature, including those that examine the relationship between support and work-stress (Viswesvaran et al., 1999), patient adherence to medical treatment (DiMatteo, 2004), and general health (Schwarzer and Leppin, 1989; Wang et al., 2003). Of particular relevance is the meta-analysis of Holt-Lunstad et al. (2010), who examined associations between mortality outcomes and various social relationship measures, including social support. Looking predominantly at point estimates from models with the fewest statistical controls, Holt-Lunstad and co-workers reported that low social support increased the risk of mortality (HR, 1.35; 95% CI, 1.22–1.49). Still, much remains unknown, especially regarding better-controlled models and potential moderators of the support-mortality relationship.

The present study offers an important addition to previous work as it examines the heterogeneity in the support-mortality association stemming from differences in the identity of support providers (family vs. friends vs. others); the degree to which support is lacking among those with lower levels of support (completely absent vs. relatively low); and the gender, age, health status, and geographic location of the support recipient. We outline below the theoretical relevance of these factors and the hypotheses associated with each.

Source of support: The literature on social support often suggests that support provided by family members and that provided by friends may have different consequences, both in terms of how this support 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). Generally, it is through one's close relationships that one receives the greatest quantity of emotional aid, small services, and companionship (Wellman and Wortley, 1990), with the bulk of support often coming from only a few strong ties (Wellman and Frank, 2001; Wellman and Wortley, 1990).

Some scholars have suggested that support coming from friends may be especially important, as friendships tend to be highly reciprocal (Wenger, 1990) and provide greater emotional support (Lee and Ishii-Kuntz, 1987). Thoits (2011) further suggests that 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. Furthermore, family members are often unfamiliar with the specific demands of the stressor, as they have never experienced it first hand, and therefore their information, advice, appraisals, and encouragement may be relatively less effective. 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, 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. They are also likely to be physically closer (often even living in the same household), to feel a greater degree of commitment, and to be more invested in solving stress-causing problems (Dupertuis et al., 2001; LaGreca et al., 1995; Primomo et al., 1990; Prohaska and Glasser, 1996; Thoits, 2011). Extended kin, however, tend to provide less support than closer family members (Wellman and Wortley, 1989). This idea that close family members may be especially important in providing support is echoed in public notions on the importance of family members in times of hardship. These notions are demonstrated by popular proverbs such as "In time of test, family is best"; "The family is a haven in a heartless world"; and most famously "Blood's thicker than water, and when one's in trouble best to seek out a relative's open arms." If that is indeed the case, we may expect the protective health effects of family support to be greater than those of friends' support.

Level of support: While most scholars agree that receiving support is beneficial, it is not clear how much support one needs in order for it to have a positive impact on health. In other words, is more always better? There may be a threshold level of support which is enough to achieve positive outcomes, with additional support beyond this threshold providing little benefit (or even becoming intrusive). Previous scholars have suggested that it is complete social isolation that is especially dangerous. Once this isolation is alleviated, even with a relatively low amount of support and social relationships, additional supportive relationships may produce only negligible improvements in health and well-being (Brummett et al., 2001; House, 2001). If this is the case, we would expect to observe increased rates of mortality primarily among socially-isolated persons.

Gender: Some former studies found that support is a significant predictor of improved health and survival in both men and women (Jylha and Aro, 1989; Seeman et al., 1993). Others, however, have argued that there are gender differences in the positive health effects of social support, with men enjoying these effects more than women. This difference may be due to the fact that women often enjoy a wider range and more sources of social support than do men (Fuhrer et al., 1999b), thus making any additional support more significant for men. Indeed, the positive effects of support were often found to be stronger in men than in women (House et al., 1982; Kaplan et al., 1988; Wilkins, 2003), though the opposite has also been reported (Lyyra and Heikkinen, 2006).

Age: Many of the previous studies on social support and mortality have focused on older-age persons (e.g., Andre-Petersson et al., 2006; Rodriguez-Artalejo et al., 2006; Rodriguez-Laso et al., 2007; Sato et al., 2007; Zhang et al., 2007). The (often implicit) assumption behind this choice is that the benefits of social support are especially pronounced in older populations. This could be due to the fact that older people are more likely to suffer from loneliness and lack of intimacy, and therefore have more to gain from emotional support. In addition, instrumental support, in particular assistance with physical and medical needs is often required more at older ages. It is important to directly test these assumptions and assess whether social support is indeed more beneficial for the elderly.

Medical conditions: Existing research has also examined the effects of social support on the health and mortality of those suffering from serious health conditions such as heart disease (Berkman et al., 1992; Brummett et al., 2005; Burg et al., 2005; Rodriguez-Artalejo et al., 2006), kidney disease (Szeto et al., 2008; Thong et al., 2007), diabetes (Zhang et al., 2007), and cancer (Saito-Nakaya et al., 2006). These studies suggest that the beneficial effects of support are especially important when one suffers from a life threatening health condition, as this is when emotional and instrumental support are most needed. If this is the case, we would expect an especially heightened mortality risk among persons with low levels of support and a serious pre-existing medical condition.

Cultural and geographic differences: Finally, cultural and geographic differences may also moderate the social support-mortality association, though it remains unclear whether it is the social aspects or the institutional aspects of culture that are more relevant. If the socio-cultural aspects are more important, one might

argue that lack of social support will have a greater effect on people's health and longevity in more traditional cultures (e.g., in East Asian countries), where close family support (emotional and instrumental) is considered part of the norm (especially at older ages; see Mason, 1992). However, if the institutional aspects are more important, support from friends and family members may be especially crucial where institutional state support is weaker. Among the developed nations, support may therefore be especially important in the United States, because it lacks a universal healthcare system and because welfare benefits may not be as generous as in some of the European nations (e.g., in Scandinavia).

3. Materials and methods

3.1. Search strategy and coding procedures

In June 2005 we conducted a search of electronic bibliographic databases to retrieve all publications combining the concepts of psychosocial stress, social isolation (including diverse measures of social relationships such as social support, network size and social participation), 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 exhausted the literature search and coding stages in January 2009, after 3.5 years and 5 search iterations (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 Section 1 of the Appendix A 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 334 publications examining the effects of social support, social participation, social network size, and social contact frequency on all-cause mortality. To evaluate coding accuracy we randomly selected and recoded 25 of these publications (153 point estimates) and found no coding errors.

The present analysis uses the subset of publications ($n = 50$; all appearing in peer-reviewed journals) that reported the effect of perceived social support (a subjective evaluation, given by respondents of the level of support they receive from others) on all-cause mortality. In consultation with a native speaker, one publication was translated from German; the remaining 49 publications were in English (see Table 1). Additional subsets of the data were used to examine the association between marital status and mortality (Roelfs et al., 2011b; Shor et al., 2012a,b) and between mortality and social participation (Shor and Roelfs, 2013).

3.2. Inclusion criteria

Studies were eligible for inclusion in the meta-analysis and meta-regression if they clearly compared a group of people who had a lower rate of self-reported support (or no support at all) and another group who had a higher rate of support, had all-cause mortality as the outcome of interest, reported a measure of statistical significance (see below), and reported a hazard ratio (or provided information sufficient to convert the results to hazard ratio format). A complete list of the social support measures used by the studies included in the meta-analysis can be found in Table 1. Studies measuring social support by assessing social network size, contact frequency, or participation in social and religious activities were excluded from the analysis (see Fig. 1 for additional details on the

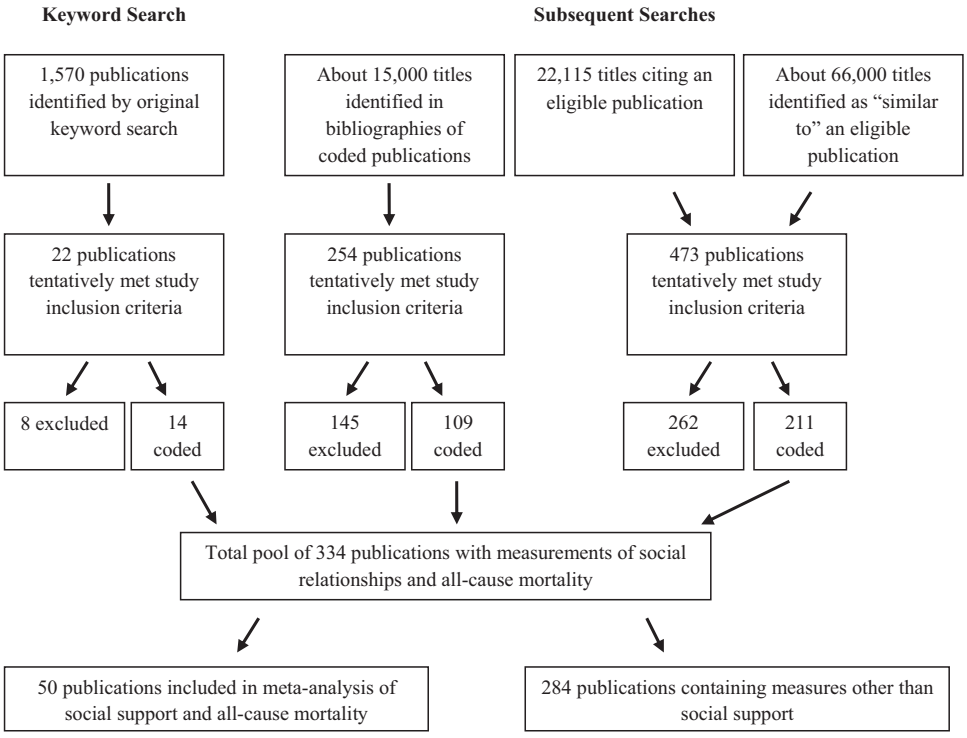

Fig. 1. Search strategy and yield.

Table 1
Studies included in the analyses.

Publication	Data source	Social support measure	Country	Years	Sample size	Mean HR[a]	Number of HRs
Andre-Petersson et al. (2006)	Men Born in 1914	Level of support (low vs. high)	Sweden	1982–1996	414	1.36	1
Berkman et al. (1992)	EPESE	Number of emotional support sources	US	1982–1989	194	2.01	2
Brummett et al. (2005)	MOSS	16-item Interpersonal Support Evaluation List	US	1992–2002	2911	1.18	4
Burg et al. (2005)	ENRICHD	Level of support (low vs. high)	US	1996–2002	1898	2.92	2
Falk et al. (1992)	Original data	Availability/adequacy of emotional support	Sweden	1982–1989	500	1.53	2
Farmer et al. (1996)	CCHP	Receiving advice from relatives and others	US	1988–1992	596	1.98	3
Fry and Debats (2006)	CSCOS	Level of satisfaction with support received	Canada	1996–2002	380	1.42	4
Fuhrer et al. (1999a,b)	PAQUID	Level of satisfaction with support received	France	1988–1994	3777	0.93	8
Giles et al. (2005)	ALSA	Number of confidants	Australia	1992–2002	1477	1.20	1
Gillum et al. (2008)	NHANES III	Level of support (low vs. high)	US	1988–2000	8450	0.92	1
Gorkin et al. (1993)	CAST-1	Level of support (low vs. high)	US	1987–1988	1322	1.52	2
Gustafsson et al. (1998)	Original data	Presence/absence of confidant	Sweden	1986–1995	421	0.95	2
Hanson et al. (1989)	Men Born in 1914	Level (low vs. high)/adequacy of support	Sweden	1982–1987	500	1.48	6
Helmert (2004)	LES of FIPR	Level of personal support (low vs. high)	Germany	1984–1998	7240	2.60	3
Helweg-Larsen et al. (2003)	DANCOS	Presence of someone to rely on/be around	Denmark	1987–1999	6693	1.13	2
Hibbard and Pope (1993)	CHR	Degree to which likes/feels sense of belonging	US	1970–1990	2502	1.12	2
Iwasaki et al. (2002)	Komo-Ise study	Number of reliable friends	Japan	1993–2000	11,565	0.90	4
Kaplan et al. (1994)	KIHDRF study	Availability/quality/satisfaction with social support	Finland	1986–1992	2503	1.51	6
Kimmel et al. (1998)	Original data	Level of support (multi-factor scale)	US	1992–1996	295	1.25	1
Kimmel et al. (2000)	Original data	Level of support (multi-factor scale)	US	1992–1997	174	1.55	3
Koenig (1995)	Original data	Level of support (low vs. high)	US	1987–1990	1011	0.94	1
Liang et al. (1999)	SHLSET	Level of emotional and instrumental support (low vs. high)	Taiwan	1989–1993	3505	1.22	1
Liang et al. (2000)	SHLCAW	Level of emotional support (low vs. high)	China	1991–1994	2765	1.13	1
Lyyra and Heikkinen (2006)	Evergreen project	Level of non-instrumental support (low vs. high)	Finland	1990–2000	206	1.81	4
Mackenbach et al. (2005)	GLOBE study	Level of emotional support (in tertiles)	Netherlands	1991–1998	5667	0.91	1
Maunsell et al. (1995)	Original data	Number of confidants	Canada	1984–1992	224	1.79	10
McClellan et al. (1993)	Original data	Presence of advising, social interaction, material aid, and emotional support	US	1987–1988	249	0.65	14
Murata et al. (2005)	Original data	Presence of someone to count on during trouble times	Japan	1992–1999	1994	0.88	4
Murberg and Bru (2001)	Original data	Level of support (5-item and 15-item scales)	Norway	1996–1998	119	1.14	3
Musick et al. (2004)	ACL	Number of confidants/level of support	US	1986–1994	3617	1.06	2
Nakanishi and Tatara (2000)	Original data	Level of difficulty in relationships	Japan	1992–1997	493	4.58	2
Nakanishi et al. (2003)	Original data	Level of difficulty in relationships	Japan	1992–2001	741	4.29	6
Okamoto et al. (2007)	Original data	Level of support (low vs. high)	Japan	1995–2001	784	0.57	2
Oxman et al. (1995)	Original data	Number of confidants	US	1989–1992	232	0.92	1
Penninx et al. (1997)	LASA	Talking to others about experiences and feelings/level of loneliness	Netherlands	1992–1995	2829	1.14	4
Rodriguez-Laso et al. (2007)	LSAL	Presence of confidant/level of emotional support (low vs. high)	Spain	1993–1999	1174	1.20	10
Romelsjo et al. (1992)	Military records	Presence of confidant	Sweden	1969–1983	8168	0.89	2
Rosengren et al. (1998)	Original data	Level of emotional support (low vs. high)	Sweden	1983–1995	717	1.87	1
Saito-Nakaya et al. (2006)	Original data	Number of confidants/satisfaction with confidants (low vs. high)	Japan	1996–2004	238	1.02	6
Sato et al. (2007)	Census, 1992	Level of emotional support (low vs. high)	Japan	1992–2004	637	0.99	8
Stimpson et al. (2007)	HEPESE	Can count on/talks about problems with family/friends	US	1993–2000	1693	0.98	4

Table 1 (*Continued*)

Publication	Data source	Social support measure	Country	Years	Sample size	Mean HR[a]	Number of HRs
Szeto et al. (2008)	Original data	Level of support (MOS-SSS-C scale)	China	2005–2005	167	1.01	1
Temkin-Greener et al. (2004)	PACE	Presence of instrumental support giver	US	1998–1999	3138	1.24	1
Thong et al. (2007)	NECOSAD-2	Level and adequacy of emotional support, general support, and companionship	Netherlands	1998–2005	528	0.94	14
Walter-Ginzburg et al. (2002)	CALAS	Presence of emotional support	Israel	1989–1997	1340	0.87	2
Walter-Ginzburg et al. (2005)	CALAS	Presence of emotional support from children/non-family	Israel	1989–1999	960	1.70	4
Welin et al. (2000)	Original data	Level of support (composite scale measure)	Sweden	1985–1997	275	1.60	2
Wilkins (2003)	NPHS	Presence of person to talk to about feelings/concerns, to count on during a crisis, get advice from, and to make feel loved/cared for	Canada	1994–2001	2422	1.00	4
Wolinsky et al. (1995)	LSOA	Level of support (5-point scale)	US	1983–1992	7527	1.18	2
Zhang et al. (2007)	LSOA	Presence of emotional support from children and level of general support (3-point scale)	US	1994–2000	1382	2.59	2

[a] The mean HR was calculated with the low social support group in the numerator and the high social support group in the denominator, so that results higher than 1.00 indicate a deleterious effect for low levels of support.

inclusion procedure). In total, the present study includes 50 publications, which provided 178 point estimates for analysis.

3.3. 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 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 sought to maximize the number of point estimates analyzed, capturing variability both between and within each publication. In cases where this caused a set of person-years to be represented more than once, we utilized a variance adjustment procedure (see Section 2 of the Appendix A).

Two measures of study quality were adopted. First, we assigned a 3-level subjective rating to each publication (individual study ratings are available upon request). Publications were rated 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 tapped 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 weighted least squares regressions of the log HRs on the inverse of the sample size (Moreno et al., 2009; Peters et al., 2006).

The following covariates were used in these analyses: (1) source of support[1]; (2) degree of support deficiency; (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; (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.

4. Results

Table 2 provides descriptive statistics on the 178 mortality risk estimates included in this study (providing data on more than 100,000 persons). Data were obtained from 50 studies published between 1989 and 2008 and covering 16 countries. Men and women are both well-represented in the dataset, as are various age groups above the age of 40. The median of studies' maximum follow-up duration was 6.12 years. Of the HRs analyzed, 98% came from studies assigned a subjective quality rating of 2 (moderate) or 3 (high); the mean 5-year impact factor was 3.56; and the mean number of citations received per year since publication was 4.12.

Table 3 presents the results of a number of meta-analyses (in addition to sample size and heterogeneity information). All analyses were stratified by the level of statistical adjustment of the risk estimate. Persons with lower support levels had a significantly higher risk of death compared to those with higher support levels. The mean unadjusted HR was 1.19 (95% confidence interval [CI], 1.09–1.42; $n = 44$ HRs); the mean age-adjusted HR was 1.42 (95% CI, 1.20–1.68; $n = 9$); and the mean HR among point estimates adjusted for age and additional covariates was 1.11 (95% CI, 1.05–1.17; $n = 121$). These results show that, in studies controlling for covariates, lower levels of emotional support are associated with an 11% higher risk of mortality.

[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/unknown, as they were defined in the relevant articles from which data were extracted.

Table 2
Distribution of mortality risk estimates ($n = 178$) in the analysis by selected variables (%).

Variable	Distribution
Source of support	
Family	25.3
Friends	11.8
Others/unknown	62.9
Publication date	
1989–1994	20.2
1995–1999	19.1
2000–2004	20.3
2005–2008	40.4
Level of statistical adjustment	
Unadjusted	27.0
Adjusted for age only	5.1
Adjusted for age and additional covariates	68.0
Gender	
Women only	24.2
Men only	28.7
Both genders	47.1
Mean age of study sample at baseline	
<40	1.7
40–49.9	12.3
50–59.9	27.6
60–69.9	15.1
70–79.9	32.6
≥80	10.7
Baseline start year	
Before 1980	2.2
1980–1984	15.2
1985–1989	28.7
1990–1994	35.4
1994–1999	17.9
2000–2005	0.6
Region/countries	
Scandinavia	17.4
United States	26.4
UK, Canada, and Australia	10.7
West Continental Europe	25.8
China and Japan	19.7
Maximum follow-up duration (years)	
1st Quartile	5.25
Median	6.12
3rd Quartile	7.66

4.1. Subgroup meta-analyses and meta-regression analyses

In the interest of presenting conservative results, from this point forward the discussion of Table 3 will focus only on HRs adjusted for age and additional covariates (constituting over two thirds of the HRs in our study). A number of important findings emerge from this table. First, the source of emotional support is very important in providing protective benefits for the individual. Individuals who received less support from family members or no such support had a higher rate of death compared to those who received relatively high levels of family support (HR, 1.15; 95% CI, 1.04–1.27; $n = 34$ HRs). However, no similar effect was found when the source of emotional support was one's friends. Table 4 presents the results of two meta-regression analyses, the first model including all the variables in the analysis and the second including only those variables significant at $p < 0.10$. Both models show that, in comparison to family sources of support, the benefits of received support are lower when the support came from either friends ($p = 0.002$) or acquaintances ($p = 0.009$).

A second interesting finding presented in Table 3 is that low levels of support may be sufficient to prevent the deleterious effects of support deficiency. Persons who reported low levels of support did not have a significantly higher risk of mortality compared to those who enjoyed high levels of support ($p = 0.089$). However, those who reported no support at all had a significantly higher risk when compared to those with high levels of support (HR, 1.17; 95% CI, 1.09–1.25; $n = 74$ HRs). As shown by the meta-regression results presented in Table 4, the difference in the magnitude of the effect between those who received no support at all and those who received at least some support is statistically significant in both Model 1 and Model 2 ($p = 0.006$ and $p = 0.001$ respectively).

Thirdly, Table 3 shows that lower support was associated with an increased risk of mortality for both women and men. The magnitude of the mean HR was approximately the same for women (HR, 1.13; 95% CI, 1.02–1.25; $n = 29$ HRs) and for men (HR, 1.09; 95% CI, 1.00–1.19; $n = 35$). The results shown in Table 4 confirm that there was no significant difference in risk between men and women ($p = 0.069$ in Model 1 and $p = 0.064$ in Model 2). Finally, the results presented in Table 3 show that low social support was harmful regardless of one's health status, but that the magnitude of the effect was greater for those who suffered from a preexisting health

Table 3
Meta-analyses of the all-cause mortality hazard for those with lower levels of support relative to those with higher levels of support.[a]

	Unadjusted			Adjusted for age only			Adjusted for age and additional covariates[b]		
	HR (95% CI)	N_{HR}	Q-test p-value	HR (95% CI)	N_{HR}	Q-test p-value	HR (95% CI)	N_{HR}	Q-test p-value
All available data	1.19 (1.09, 1.31)***	48	0.002	1.42 (1.20, 1.68)***	9	0.084	1.11 (1.05, 1.17)***	121	0.416
By source of support									
Family	1.23 (0.78, 1.94)	11	0.785	–	0	–	1.15 (1.04, 1.27)**	34	0.783
Friends	1.08 (0.80, 1.46)	7	0.763	–	0	–	0.99 (0.84, 1.17)	14	0.982
Others/unknown	1.25 (1.12, 1.40)***	30	0.000	1.44 (1.19, 1.73)***	9	0.183	1.15 (1.07, 1.24)***	73	0.019
By level of support deficiency (compared with high support)									
No support	1.27 (1.14, 1.41)***	28	0.000	1.66 (1.34, 2.06)***	7	0.479	1.17 (1.09, 1.25)***	74	0.004
Low support	1.03 (0.81, 1.32)	20	0.798	1.00 (0.71, 1.41)	2	0.562	1.08 (0.99, 1.17)	47	0.993
By preexisting health condition									
No health problems	1.18 (1.07, 1.34)**	25	0.000	1.43 (1.20, 1.72)***	9	0.149	1.11 (1.04, 1.18)**	86	0.133
Health problems	1.31 (1.08, 1.61)**	23	0.345	–	0	–	1.20 (1.07, 1.35)**	35	0.338
By gender									
Women	1.39 (1.01, 1.93)*	11	0.339	1.56 (1.23, 1.97)***	3	0.047	1.13 (1.02, 1.25)*	29	0.042
Men	1.62 (1.33, 1.98)***	10	0.858	1.31 (1.09, 1.58)**	6	0.075	1.09 (1.00, 1.19)*	35	0.591

[a] All meta-analyses calculated by maximum likelihood using a random effects model ($N_{HR} = 178$). Number reported is the mean HR (95% confidence interval). Ellipses indicate situations where $n \leq 1$ and meaningful mean HR could not be calculated.
[b] The number and type of covariates varies between studies.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

Table 4
Multivariate meta-regression analyses predicting the magnitude of the effect of social support on mortality.[a]

	Model 1: all variables	Model 2: parsimonious[b]
Constant	0.88 (0.60, 1.30) [$p = 0.520$]	0.87 (0.73, 1.04) [$p = 0.136$]
Source of support		
Family[c]	Reference	
Friends	0.87 (0.80, 0.95) [$p = 0.002$]	0.88 (0.80, 0.95) [$p = 0.002$]
Others/unknown	0.93 (0.86, 1.00) [$p = 0.055$]	0.92 (0.86, 0.98) [$p = 0.009$]
Degree of support deficiency (0 = no support; 1 = low support)	0.90 (0.84, 0.97) [$p = 0.006$]	0.90 (0.84, 0.96) [$p = 0.001$]
Preexisting health condition (1 = yes)	1.23 (1.10, 1.37)	1.27 (1.20, 1.34)
Proportion of sample that is male	0.91 (0.83, 1.01) [$p = 0.069$]	0.92 (0.84, 1.00) [$p = 0.064$]
Mean age at baseline (decades)	1.05 (1.03, 1.08)	1.06 (1.04, 1.07)
Study age (decades)	1.11 (1.03, 1.19) [$p = 0.006$]	1.15 (1.09, 1.20)
HR controlled for		
Gender	1.08 (0.99, 1.17) [$p = 0.073$]	1.08 (1.00, 1.16) [$p = 0.054$]
Age	1.12 (1.04, 1.21) [$p = 0.002$]	1.12 (1.06, 1.19)
General health	0.83 (0.76, 0.90)	0.83 (0.77, 0.90)
Sample size (logged)	0.97 (0.95, 1.00) [$p = 0.068$]	0.97 (0.94, 1.00) [$p = 0.028$]
Geographical region		
United States	Reference	
Scandinavia	1.12 (1.01, 1.25) [$p = 0.035$]	
Commonwealth	1.02 (0.88, 1.19) [$p = 0.792$]	
Central Europe	0.95 (0.83, 1.07) [$p = 0.401$]	
East Asia	0.97 (0.88, 1.07) [$p = 0.564$]	
Subjective quality rating	1.02 (0.93, 1.11) [$p = 0.680$]	
Scale measure of study quality	1.00 (0.97, 1.03) [$p = 0.860$]	
R^2	0.4435	0.4071

[a] All meta-regressions calculated by maximum likelihood using a random effects model ($n = 178$). Number reported is the exponentiated regression coefficient (95% confidence interval) [p-value]. Unless otherwise indicated, p-values ≤ 0.001. Ellipses indicate when a variable was not included in the model.
[b] Obtained using backwards elimination, $p > 0.10$ to exit.
[c] Including both family of origin and family of procreation.

condition (HR, 1.20; 95% CI, 1.07–1.35; $n = 35$ HRs) than for those with normal health (HR, 1.11; 95% CI, 1.04–1.18; $n = 86$ HRs). This difference in magnitude was statistically significant, as shown in the results of the two meta-regression models presented in Table 4 ($p < 0.001$ in both models).

Table 4 shows that other significant predictors of the magnitude of the HR in the parsimonious model include mean age at baseline (a 6% increase for every 10 years of age; $p < 0.001$), the age of the data used in a study ("study age"; a 15% increase each additional 10 years since data collection; $p = 0.006$), the sample size ($p = 0.028$), and whether or not the study controlled for age (a 12% increase if age was controlled; $p < 0.001$). Somewhat surprisingly, the geographical region in which studies were conducted had virtually no influence on the magnitude of the mean HR. While there was a slight difference in HR magnitude between the United States and Scandinavia in Model 1 ($p = 0.035$), there were no regional differences in the final, parsimonious model, suggesting that studies conducted in diverse locales were largely comparable. Finally, both measures of study quality were non-significant predictors of HR magnitude ($p = 0.680$ for the subjective measure and $p = 0.860$ for the scale measure), indicating that the results are not biased due to the inclusion of a small number of primary studies with lower quality ratings.

4.2. Analysis of data heterogeneity

The between-groups Cochrane's Q for the meta-analysis of all 178 HRs was statistically significant ($p < 0.05$; I^2, 83.04; 95% CI, 48.39, 94.43), and the unexplained heterogeneity variance component from both meta-regression models was also significant ($p < 0.001$ in both cases), indicating that important moderating variables exist and 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 age and additional covariates, the corresponding heterogeneity test results were carefully examined. As shown in Table 3, the Q-tests for these sub-group meta-analyses were statistically significant for only three cases, the others/unknown source of support sub-group ($p = 0.019$), the "no support" sub-group ($p = 0.004$), and the women sub-group ($p = 0.042$). I^2 tests for these subgroups indicate heterogeneity was relatively low for the others/unknown sub-group (I^2, 27.35; 95% CI, 2.39–45.93), the no support sub-group (I^2, 33.12; 95% CI, 10.76–49.88), and the women sub-group (I^2, 33.61; 95% CI, 4.55––57.84). In all of the remaining subgroup analyses, Q-tests and I^2 tests were non-significant. We therefore conclude that heterogeneity was adequately accounted for by the use of a random effects model.

4.3. 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 HRs. Therefore, one should be especially careful in interpreting mean HRs which are relatively close to 1, even when these are significant. The results from Table 4 show that study sample size was significantly related to the magnitude of the HR ($p = 0.028$) but that the strength of this relationship was weak, suggesting that publication bias was minimal. This observation is also reflected in the funnel plot of the log HRs against sample size, which appears symmetric around the mean HR (see Fig. 2). The results from Peters et al.'s test (Moreno et al., 2009; Peters et al., 2006) formally confirm that publication bias was not a significant problem ($p = 0.574$).

5. Discussion

The results of the present meta-analyses and meta-regression analyses showed that social support tended to be beneficial for people's health, but the magnitude of the effect was not very large. Among HRs adjusted for age and additional covariates, the

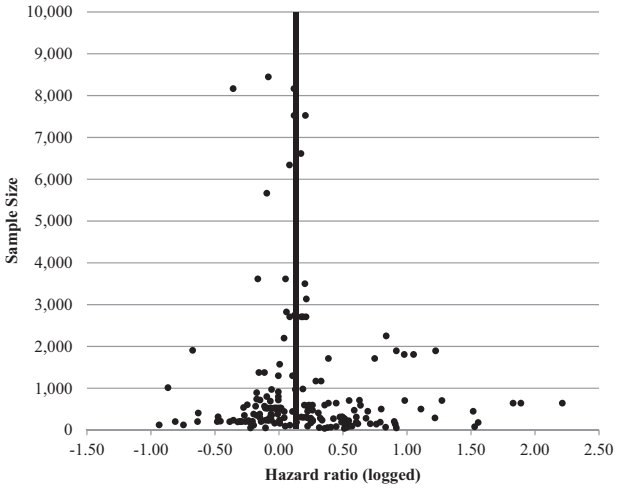

Fig. 2. Funnel plot of hazard ratios (logged) vs. sample size.

risk of death for people with lower social support levels was 11% higher than the risk among those with higher levels of social participation. While this effect is statistically significant, its magnitude is lower than that found in another recent meta-analysis of social support and mortality (Holt-Lunstad et al., 2010), which reported a 35% increase. The difference between these results and those of the present study is likely the result of differences in inclusion criteria. Holt-Lunstad and co-workers selected risk estimates that were minimally-adjusted for covariates. The present study included both minimally-adjusted risk estimates and those that were statistically-adjusted for potential confounders of the support-mortality association. The comparison of the two sets of risk estimates highlights the importance of controlling for each respondent's health status at baseline. The results presented in Table 4 show that the mean HR among studies that controlled for baseline health was 17% lower when compared to those that did not ($p < 0.001$). Future studies should therefore make every effort to control, at the very least, for general health, age, and gender (controlling for the latter two factors was also found to be important in the present study) in order to reduce bias when estimating the magnitude of the effect.

Furthermore, the magnitude of the effect was not uniform across all of the subgroups examined. One of the interesting findings coming out of our study is that while support from family members clearly decreases people's risk of mortality, support from friends was not found to have a significant effect. These findings provide backing for the common belief that support from family members is invaluable in times of need and is not easily replaced by support from others. The support mechanisms provided primarily by family members, including discussions of health issues and symptoms (Brody et al., 1983; Stoller et al., 1997) and the provision of physical and material assistance when one is ill (Dupertuis et al., 2001; Friedman, 1993; Primomo et al., 1990), appear to be especially important for people's health and longevity.

That said, one needs to be careful in the interpretation of these results, especially regarding the non-significant effect of support from friends. First, the number of HRs classified as friends-only support was relatively low (only 14 HRs). More than half of the point estimates (73 out of 121 HRs adjusted for age and additional covariates) did not report the specific source of support, and it is possible that many of these were based primarily on support from friends. Given that the effect of support in this "unidentified-source" subgroup was comparable to the effect in the family-only support group (a 15% higher risk for those with low support in both cases) it is quite possible that the effect of support from friends was more substantial than could be assessed in the present study. Such caution is warranted as previous research has often found that support from friends had a substantial effect on morale and emotional coping (Dupertuis et al., 2001; LaGreca et al., 1995).

A second interesting finding has to do with the amount of support provided. We found that even low levels of support were enough to provide a protective effect, as there was no significant difference between those with some support and those with more substantial support. This finding is in line with the theoretical supposition of previous scholars (Brummett et al., 2001; House, 2001), who argued that the main dangers to one's health come from social isolation. Thus, even a moderately low amount of support may be helpful in alleviating feelings of isolation. However, one must be careful not to conclude that higher levels of support are redundant in terms of health outcomes. Substantial differences remain in how studies assess support levels, and further research is needed that directly compares various levels of support.

In accordance with our hypothesis, the support recipient's level of need is an important moderator of the support-mortality association. First, we found that social support is especially beneficial at older ages, most likely because older people tend to suffer from more health problems and need greater instrumental and emotional assistance as a result. As shown in Table 4, each ten year increase in the mean age of a sample was associated with a 6% increase in the mean HR ($p < 0.001$). In addition, we found that the lack of social support was more detrimental among those who suffered from a serious health condition (such as cancer, heart disease, and kidney disease) prior to the beginning of the study. As shown in Table 4, the mean HR was 27% higher for those with documented health problems when compared to those with a normal health distribution ($p < 0.001$). These findings highlight the importance of assessing support availability among older populations and those who suffer from serious illnesses. Health-care providers and social welfare advocates should pay special attention to these populations, as they are the ones most likely to suffer if instrumental or emotional help are unavailable.

The findings of the present study also show that the lack of social support is equally detrimental for both men and women. As shown in Table 4, no significant difference in the magnitude of the mean HR exists between the two genders ($p = 0.064$). However, this does not mean that there is no relationship between gender and the likelihood that one will fall into the low social support group. For example, Kalmijn (2007) showed that when parents divorce, the male partner tends to experience a more drastic reduction in social support from their children than does the female partner. Nonetheless, the results of the present study show that both men and women suffer from being in the low social support group.

Finally, in contrast to our hypothesis, there was very little difference in the magnitude of the relative mortality risk between the various geographical regions. We did not find support for the idea that a lack of social support would be especially detrimental in those places with stronger norms of family support. Likewise, we did not find support for the supposition that a lack of support would be more harmful in places with less universal health care or welfare systems. The findings suggest instead that the positive effects of social support on health are quite universal across cultures and geographical locations. We need to be careful, however, not to assume that the mechanisms linking social support and health outcomes are identical across cultures and regions. It should further be noted that almost none of the research reported in the literature was conducted in developing nations. We found no studies that examined the effects of social participation in Africa, in South or Central Asia, or in South or Central America. It is important to conduct studies in these locales before concluding that the effects of social participation are indeed uniform across cultures.

Table A1
Illustration of adjustments made to the inverse variance weights to correct for multiple reporting.

Study	Gender	Age	Original inverse variance weight	Corrected inverse variance weight
Study X	Men only	All ages	4	4
Study X	Women only	All ages	2	2
Study Y	Men only	20–44	5	5
Study Y	Men only	45–65	7	7
Study Y	Men only	65+	3	3
Study Z	Men only	All ages	12	6
Study Z	Women only	All ages	20	10
Study Z	Both men and women	20–44	16	8
Study Z	Both men and women	45–65	24	12
Study Z	Both men and women	65+	16	8

Appendix A. Additional methodological information

Section 1: 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.

Section 2: Additional information on the adjustment of variance weights: In cases where a given set of person-years was represented more than once, we utilized a variance adjustment procedure which divides the variance weight by the number of times a particular cohort appears in an analysis. For example, when a publication (see hypothetical Study X in Table A1) reported mortality risks by gender sub-groups alone the data requires no adjustment. Likewise, when a study reported mortality risks by age group alone (see hypothetical Study Y) the data also requires no adjustment. When a publication first reports mortality risks by gender and then again by age (see hypothetical Study Z) however, this creates a violation of independence because each person is represented twice. To correct for this double-counting, each of the variance weights was adjusted to half of its original value, thus preserving information on the gender and age variables but counting each subject only once.

Variance adjustment was performed using a syntax designed to identify sample overlap in terms of gender, level of statistical adjustment, ethnicity, restrictions on the sampling frame (e.g., if the sample consisted of only veterans), age range, and follow-up duration. With respect to gender, for example, the syntax examined all point estimates taken from studies using the same data source (e.g., the 1960 U.S. census) and individually classified each point estimate into one of three gender categories (men only, women only, and a gender mixture). If the point estimates corresponding to a single data source contained examples where men and women were analyzed separately and examples where men and women were analyzed together, we concluded that sample duplication was present and the gender adjustment factor was set to 0.5. If, on the other hand, all point estimates corresponding to a particular data source were of the same type (i.e., only men and women separately or only men and women together), we concluded that sample duplication was not present with respect to gender and the gender adjustment factor was set to 1 (i.e., no adjustment to the variance weight). The calculation of the remaining adjustment factors for level of statistical adjustment, ethnicity, restrictions on the sampling frame, age range, and follow-up duration were structured similarly. In the few instances when one or more point estimates corresponding to a single data source matched on all six of the above criteria, we manually examined each case to determine where the source of duplication lay and to subsequently determine a seventh and final adjustment factor.

The adjusted variance weight used in the meta-regressions was calculated by taking the product of the original, unadjusted variance weight and each of the seven adjustment factors. The adjusted variance weight used in each of the meta-analyses was calculated similarly, but did not include the adjustment factors corresponding to the stratification variables used. For example, the calculation of the adjusted variance weights for the meta-analyses that were stratified by gender and statistical-adjustment-level did not include the gender or the statistical-adjustment-level adjustment factors.

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