The Strength of Family Ties:

A Meta-Analysis and Meta-Regression of Self-Reported Social Support and Mortality

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 HR increases with age, but no substantial difference was found between men and women in the magnitude of the risk.

Key Words: social support; family; friends; mortality; meta-analysis; meta-regression

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"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 (P. Thoits, 2011). The literature (e.g. House & Kahn, 1985; Lin & Westcott, 1991) identifies three main such 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. Support has been linked to better mental health (Dalgard, Bjork, & Tambs, 1995; Dressler, 1985; Mathiesen, Tambs, & Dalgard, 1999), to lower susceptibility to cancer (Ell, Nishimoto, Mediansky, Mantell, & Hamovitch, 1992; Hibbard & Pope, 1993; L. Welin, Larsson, Svardsudd, Tibblin, & Tibblin, 1992), infectious diseases (Cohen, 1991; M. Lee & Rotheram-Borus, 2001; Patterson, Shaw, Semple, Cherner, McCutchan, Atkinson et al., 1996) and cardiovascular diseases (Johnson & Hall, 1988; Lepore, Allen, & Evans, 1993; Roy, Steptoe, & Kirschbaum, 1998), and to lower overall and cause-specific mortality rates (Andre-Petersson, Hedblad, Janzon, & Stergren, 2006; Berkman, Leo-Summers, & Horwitz, 1992; Beverly H.

Brummett, Mark, Siegler, Williams, Babyak, Clapp-Channing et al., 2005; Hanson, Isacsson, Janzon, & Lindell, 1989; Lyyra & Heikkinen, 2006; Zhang, Norris, Gregg, & Beckles, 2007).

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, self-worth, self-competence, and emotional sustenance (Barrera, 2000; Berkman, Glass, Brissette, & Seeman, 2000; House, 2001; P. Thoits, 2011; Uchino, 2006; Umberson & 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, Wilson, Cohen, Kauhanen, Wu, & Salonen, 1994; Uchino, 2004, 2006; Uchino, Cacioppo, & Kiecolt-Glaser, 1996). This occurs either by way of actively regulating one's behaviors or by way of providing information about healthy practices (Lyyra & 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, Aldwin, & Bosse, 2001; Schwarzer & Leppin, 1991).

The present study uses meta-analysis and meta-regression to further examine the association between perceived social support (instrumental, emotional, and informational) and all-cause mortality. 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 & Tatara, 2000; Adrian Walter-Ginzburg, Shmotkin, Blumstein, & Shorek, 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, King, Obisesan, & Koenig, 2008; Koenig, 1995; Okamoto, Harasawa, Momose, & Sakuma, 2007; Oxman, Freeman, & Manheimer, 1995; Saito-Nakaya, Nakaya, Fujimori, Akizuki, Yoshikawa, Kobayakawa 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. P. Thoits, 2011; Uchino, 2009; Umberson, Crosnoe, & Reczek, 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; Teresa E. Seeman, 1996; P. Thoits, 2011; P. A. Thoits, 1995). 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, Sanchez, & Fisher, 1999), patient adherence to medical treatment (DiMatteo, 2004), and general health (Schwarzer & Leppin, 1989; Wang, Wu, & Liu, 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 colleagues 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.

Moderating Factors in the Support-Mortality Association

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 of the factors.

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 & Antonucci, 1989; Rook, 1987; T. E. Seeman &

Berkman, 1988) and in terms of its mental-health and physiological-health outcomes (Gallant, Spitze, & Prohaska, 2007; Matt & Dean, 1993; Potts, 1997).

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 (G. R. Lee & 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, especially those with weaker ties to the person, may be more helpful in providing important information and advice, tailored to the specific problem at hand. If they are peers, they may sometimes also be more likely to be able to take the role of the distressed person and anticipate his or her emotional reactions and practical concerns.

Others scholars, however, have argued that family members (especially parents, siblings, children and spouses) 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, Auslander, Greco, & Spetter, 1995; Primomo, Yates, & Woods, 1990; Prohaska & Glasser, 1996; P. Thoits, 2011). This idea that 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 (B. H. Brummett, Barefoot, Siegler, Clapp-Channing, Lytle, Bosworth 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 & Aro, 1989; Teresa E. Seeman, Berkman, Kohout, Lacroix, Glynn, & Blazer, 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, Stansfeld, Chemali, & Shipley, 1999), 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, Robbins, & Metzner, 1982;

Kaplan, Salonen, Cohen, Brand, Syme, & Puska, 1988; Wilkins, 2003), though the opposite has also been reported (Lyyra & 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, Guallar-Castillon, Herrera, Otero, Chiva, Ochoa et al., 2006; Rodriguez-Laso, Zunzunegui, & Otero, 2007; Sato, Kishi, Suzukawa, Horikawa, Saijo, & Yoshioka, 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 in 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; Beverly H. Brummett et al., 2005; Matthew M. Burg, Barefoot, Berkman, Catellier, Czajkowski, Saab et al., 2005; Rodriguez-Artalejo et al., 2006), kidney disease (Szeto, Chow, Kwan, Law, Chung, Leung et al., 2008; Thong, Kaptein, Krediet, Boeschoten, Dekker, & Netherlands Cooperative Study, 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).

MATERIALS AND METHODS

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 (see Section 1 of Appendix for the full search algorithm used for Medline; information on the remaining 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.

Both 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 2 of the 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. **Figure 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.

Insert Figure 1 about here

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 (Authors [in press]) and between mortality and social participation (Authors [unpublished]).

Insert Table 1 about here

Inclusion Criteria

Over the years, social support has been measured in a variety of ways, including participation in social and religious activities, the size of one's network of relationships, and the frequency with which one contacts others. However, as O'Reilly (1988: p. 869) points out, while some of these items might be considered indirect indicators of support, they often measure multiple support dimensions, including "social participation, social isolation, state of personal well-being, and most often components of social networks". Studies found that "supportive" social ties can sometimes encourage risky and unhealthy behaviors such as cigarette smoking, drug use, and reckless driving (M. M. Burg & Seeman, 1994; Uchino, 2006; Wills & 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, Hershberger, Russell, & Markert, 2001; Ruehlman & Karoly, 1991).

Consequently, many researchers have moved to measures of self-reported social support, assessed through items such as one's ability to rely on others, having someone trustworthy to confide in, satisfaction with interactions and companionship, availability and adequacy of emotional ties, and reports of tangible instrumental help with daily-life activities (e.g., Andre-Petersson et al., 2006; Berkman et al., 1992; Beverly H. Brummett et al., 2005; Penninx, vanTilburg, Kriegsman, Deeg, Boeke, & vanEijk, 1997; Saito-Nakaya et al., 2006; Thong et al., 2007). Unfortunately, only a very small minority among these studies differentiate clearly between instrumental, informational, and emotional support, preventing us from testing the effects of each of these separately. Furthermore, one must acknowledge the dangers in relying on subjective measures, as these may be influenced by one's personality, mood, or cultural upbringing. Nevertheless, such measures better reflect people's actual perceived sense of support. "Objective" measures of support, such as counts of the number of friends or children one has, are not affected by the subjective factors listed above, but nonetheless have their own drawbacks. Counts of social ties aggregate supportive and non-supportive relationships, and as a result cannot be relied upon to measure the amount of tangible support and comfort people feel they receive from their social relationships.

Following this logic, we restricted our analysis to studies that 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, with an outcome variable of all-cause mortality. Studies including only proxy measurements of social support, such as one's social network size, contact frequency, or participation in social and religious activities were excluded from the analysis (see figure 1 for additional details on the inclusion procedure). In total, the present study includes 50 publications, which provided 178 point estimates for analysis.

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; See Section 3 of Appendix for further details on conversion procedures). 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 4 of the Appendix).

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 to 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=.296; $p<.001$), 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, Sanchez-Meca, & Marin-Martinez, 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, Sutton, Ades, Stanley, Abrams, Peters et al., 2009; Peters, Sutton, Jones, Abrams, & Rushton, 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.

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.

Insert Table 2 about here

Table 3 presents the results of a number of meta-analyses (in addition to sample **s**ize 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

[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.

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.

Insert Table 3 about here

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 ($p = 0.009$).

Insert Table 4 about here

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 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.

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.

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 & Parker, 2002; Egger & 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 **Figure 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 ($p = 0.574$).

Insert Figure 2 about here

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 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 colleagues 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, Kleban, & Moles, 1983; Stoller, Kart, & Portugal, 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 (B. H. 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.

Figure 1. Search Strategy and Yield

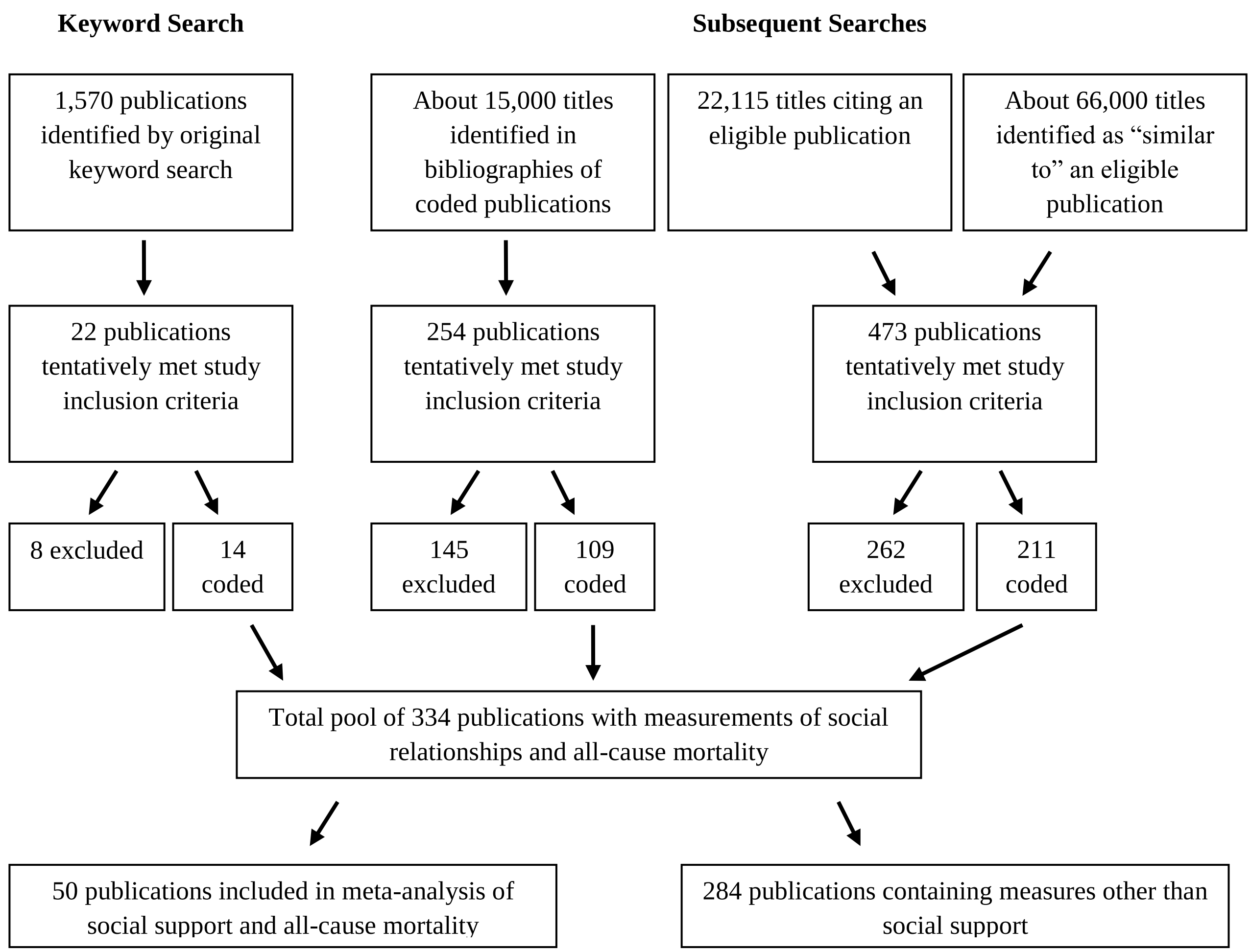
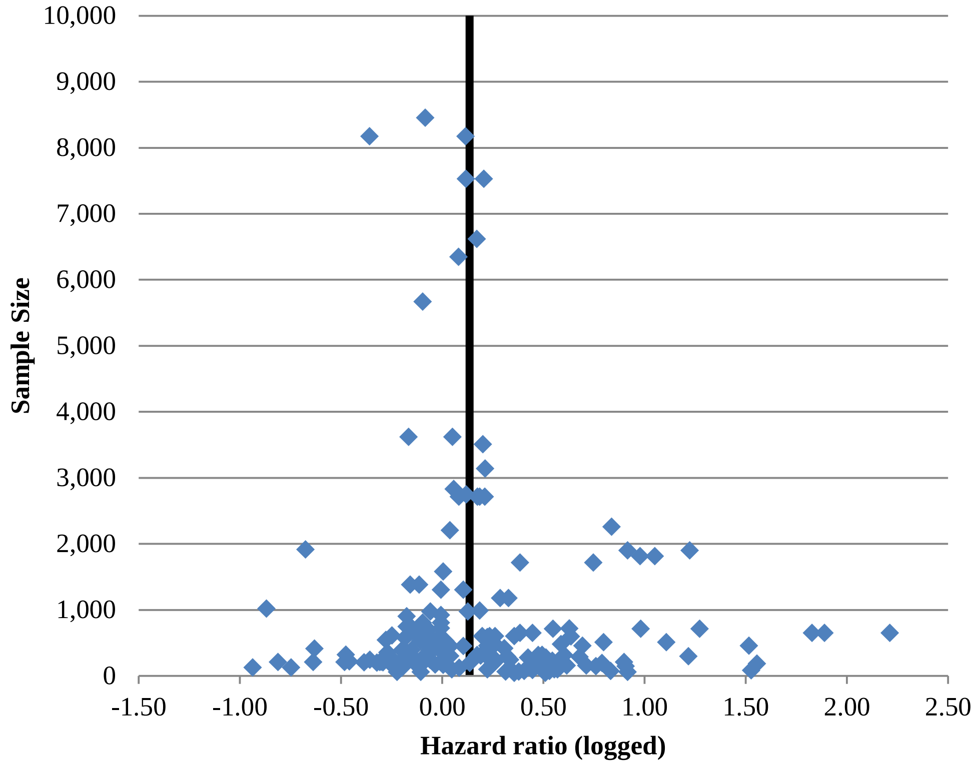


Figure 2. Funnel plot of hazard ratios (logged) vs. sample size



Vertical line denotes the mean hazard ratio (logged) of 0.1351

Table 1. Studies Included in the Analyses						
Publication	**Data Source**	**Country**	**Years**	**Sample Size**	**Mean HR***	**Number of HRs**
Andre-Petersson et al. 2006	Men Born in 1914	Sweden	1982-1996	414	1.36	1
Berkman et al. 1992	EPESE	US	1982-1989	194	2.01	2
Brummett et al. 2005	MOSS	US	1992-2002	2,911	1.18	4
Burg et al. 2005	ENRICHD	US	1996-2002	1,898	2.92	2
Falk et al. 1992	Original Data	Sweden	1982-1989	500	1.53	2
Farmer et al. 1996	CCHP	US	1988-1992	596	1.98	3
Fry and Debats 2006	CSCOS	Canada	1996-2002	380	1.42	4
Fuhrer et al. 1999	PAQUID	France	1988-1994	3,777	0.93	8
Giles et al. 2005	ALSA	Australia	1992-2002	1,477	1.20	1
Gillum 2008	NHANES III	US	1988-2000	8,450	0.92	1
Gorkin et al. 1993	CAST-1	US	1987-1988	1,322	1.52	2
Gustafsson et al. 1998	Original Data	Sweden	1986-1995	421	0.95	2
Hanson et al. 1989	Men Born in 1914	Sweden	1982-1987	500	1.48	6
Helmert 2004	LES of FIPR	Germany	1984-1998	7,240	2.60	3
Helweg-Larsen et al. 2003	DANCOS	Denmark	1987-1999	6,693	1.13	2
Hibbard and Pope 1993	CHR	US	1970-1990	2,502	1.12	2
Iwasaki et al. 2002	Komo-Ise Study	Japan	1993-2000	11,565	0.90	4
Kaplan et al. 1994	KIHDRF Study	Finland	1986-1992	2,503	1.51	6
Kimmel 1998	Original Data	US	1992-1996	295	1.25	1
Kimmel et al. 2000	Original Data	US	1992-1997	174	1.55	3
Koenig 1995	Original Data	US	1987-1990	1,011	0.94	1
Liang et al. 1999	SHLSET	Taiwan	1989-1993	3,505	1.22	1
Liang et al. 2000	SHLCAW	China	1991-1994	2,765	1.13	1
Lyyra and Heikkinen 2006	Evergreen Project	Finland	1990-2000	206	1.81	4
Mackenbach et al. 2002	GLOBE Study	Netherlands	1991-1998	5,667	0.91	1
Maunsell et al. 1995	Original Data	Canada	1984-1992	224	1.79	10
McClellan et al. 1993	Original Data	US	1987-1988	249	0.65	14
Murata et al. 2005	Original Data	Japan	1992-1999	1,994	0.88	4
Murberg and Bru 2001	Original Data	Norway	1996-1998	119	1.14	3
Musick et al. 2004	ACL	US	1986-1994	3,617	1.06	1
Nakanishi and Tatara 2000	Original Data	Japan	1992-1997	493	4.58	2
Nakanishi et al. 2003	Original Data	Japan	1992-2001	741	4.29	6
Okamoto et al. 2007	Original Data	Japan	1995-2001	784	0.57	2
Oxman et al. 1995	Original Data	US	1989-1992	232	0.92	1
Penninx et al. 1997	LASA	Netherlands	1992-1995	2,829	1.14	4
Rodriguez-Laso et al. 2007	LSAL	Spain	1993-1999	1,174	1.20	10
Romelsjo et al. 1992	Military Records	Sweden	1969-1983	8,168	0.89	2
Rosengren et al. 1998	Original Data	Sweden	1983-1995	717	1.87	1
Saito-Nakaya et al. 2006	Original Data	Japan	1996-2004	238	1.02	6
Sato et al. 2007	Census, 1992	Japan	1992-2004	637	0.99	8
Stimpson et al. 2007	HEPESE	US	1993-2000	1,693	0.98	4
Szeto et al. 2008	Original Data	China	2005-2005	167	1.01	1
Temkin-Greener et al. 2004	PACE	US	1998-1999	3,138	1.24	1
Thong et al. 2007	NECOSAD-2	Netherlands	1998-2005	528	0.94	14
Walter-Ginzburg et al. 2002	CALAS	Israel	1989-1997	1,340	0.87	2
Walter-Ginzburg et al. 2005	CALAS	Israel	1989-1999	960	1.70	4
Welin et al. 2000	Original Data	Sweden	1985-1997	275	1.60	2
Wilkins 2003	NPHS	Canada	1994-2001	2,422	1.00	4
Wolinsky 1995	LSOA	US	1983-1992	7,527	1.18	2
Zhang et al. 2007	LSOA	US	1994-2000	1,382	2.59	2

* 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.

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

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	.002	1.42 (1.20, 1.68)***	9	.084	1.11 (1.05, 1.17)***	121	.416
By source of support									
Family	1.23 (0.78, 1.94)	11	.785	--	0	--	1.15 (1.04, 1.27)**	34	.783
Friends	1.08 (0.80, 1.46)	7	.763	--	0	--	0.99 (0.84, 1.17)	14	.982
Others/unknown	1.25 (1.12, 1.40)***	30	.000	1.44 (1.19, 1.73)***	9	.183	1.15 (1.07, 1.24)***	73	.019
By level of support deficiency (compared with high support)									
No support	1.27 (1.14, 1.41)***	28	.000	1.66 (1.34, 2.06)***	7	.479	1.17 (1.09, 1.25)***	74	.004
Low support	1.03 (0.81, 1.32)	20	.798	1.00 (0.71, 1.41)	2	.562	1.08 (0.99, 1.17)	47	.993
By Preexisting health condition									
No health problems	1.18 (1.07, 1.34)**	25	.000	1.43 (1.20, 1.72)***	9	.149	1.11 (1.04, 1.18)**	86	.133
Health problems	1.31 (1,08, 1.61)**	23	.345	--	0	--	1.20 (1.07, 1.35)**	35	.338
By gender									
Women	1.39 (1.01, 1.93)*	11	.339	1.56 (1.23, 1.97)***	3	.047	1.13 (1.02, 1.25)*	29	.042
Men	1.62 (1.33, 1.98)***	10	.858	1.31 (1.09, 1.58)**	6	.075	1.09 (1.00, 1.19)*	35	.591

*** $p<.001$ ** $p<.01$ * $p<.05$

[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≤1 and meaningful mean HR could not be calculated.

[b] The number and type of covariates varies between studies.

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	.4435	.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>.10 to exit.
[c] Including both family of origin and family of procreation.

Appendix: 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.

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 & women	20-44	16	8
Study Z	Both men & women	45-65	24	12
Study Z	Both men & women	65+	16	8

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 .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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