A Systematic Review of Retirement as a Risk Factor for Mortality

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Matthew J. Shim, PhD, MPH, MA[1]
David Gimeno, PhD[2, 3]
Sandi L. Pruitt, PhD, MPH[4]
Christopher B. McLeod, MA[5, 6]
Margaret J. Foster, MS[7]
Benjamin C. Amick, III, PhD[8, 3]

Affiliations:

1- US Air Force School of Aerospace Medicine, Epidemiology Consult Service (USAFSAM/PHR), Brooks City-Base, TX, USA
2- The University of Texas Health Sciences Center at Houston, School of Public Health, Division of Environmental and Occupational Health Sciences, San Antonio Regional Campus, San Antonio, TX, USA
3- Institute for Work & Health, Toronto, ON, Canada
4- Washington University School of Medicine, Division of Health Behavior Research, St. Louis, MO, USA
5- The University of British Columbia, School of Population and Public Health, Vancouver, BC, Canada
6- The University of British Columbia, Centre for Health Services and Policy Research, Vancouver, BC, Canada
7- Texas A&M University Libraries, College Station, TX, USA
8- The University of Texas Health Sciences Center at Houston, School of Public Health, Southwest Center for Occupational and Environmental Health, Houston, TX, USA

Abstract

The relationship between retirement and health is not well established. Research examining retirement as a risk factor for mortality is sparse and heterogeneous in terms of the definition of retirement, the analytic methods used and consequently the findings reported. A systematic literature review using a modified Cochrane and 'best evidence synthesis' approach answered the question—Does the research literature support the view that type of retirement is a risk factor for mortality? We identified 1,126 studies related to retirement and mortality. After exclusions based on content and quality, 13 studies remained for data extraction and evidence synthesis. We found a strong and sufficient level of evidence suggesting that all-type retirement is a risk factor for mortality. However, there is only mixed evidence regarding the relationship between specific types of retirement (i.e., on-time, early and health-related) and mortality. No conclusion can be made about specific retirement types and mortality.

Introduction

Ageing, health and retirement are closely related in modern industrialized societies such as the United States. Starting in the 1800s and continuing through the early 1900s, old age pensions, fixed age retirement and government sponsored pension plans were introduced by Germany, France and England which meant that persons no longer had to work until they died or rely on friends and family for support in their old age (Streib & Schneider, 1971). The ageing population in the US is dramatically increasing. The US Census Bureau (2006) estimated that 78.2 million of the baby boomer generation, born between 1946 and 1964, were alive, representing 30% of the US population. In 2006, the oldest of this generation turned 60 years old. The Census also estimates that persons age 65 and older will total about 13% of the US population by 2010, and 19% by 2025 (Campbell, 1996). These changes could overwhelm the public and private social security and health care insurance and delivery systems (Gebbie, Koplan, Fox, & Marks, 2005).

Retirement is a change in employment status, from working to non-working, that is usually expected to coincide with a predetermined age (e.g., 65), predetermined length of service (e.g., 20 or 30 years) or health deterioration (e.g., physical disability) (Streib & Schneider, 1971). Three basic types of retirement can be defined: 1) on-time retirement, when a worker stops working on or after a predetermined age or length of service; 2) health-related retirement, when a worker stops working either on, after or prior to a predetermined age or length of service due to ill-health and/or disability; and, 3) early retirement, when a worker stops working prior to a predetermined age or length of service where ill-health and/or disability are not a factor.

The relationship between retirement and health is not well defined (Kasl & Jones, 2000). There is no consensus on the definition or measurement of retirement as an exposure or risk factor for mortality. Current social research tends to focus on the association between unemployment, job loss and/or job transition and health outcomes (Breeze, Fletcher, Leon, Marmot, Clarke, & Shipley, 2001; Gallo, Bradley, Falba, et al., 2004; Henriksson, Lindblad, Agren, Nilsson-Ehle, & Rastam, 2003; Kasl, 1996; vanAmelsvoort, Kant, Bultmann, & Swaen, 2003) with only a cursory mention of retirement. When retirement is the exposure of interest, the focus has been on the relationship between retirement and mortality without discussing retirement types (Gallo et al., 2004; Marmot & Shipley, 1996; Moen, 1996).

Two conflicting health beliefs are associated with retirement: 1) retire early and live longer and 2) retire and die sooner (Anderson, 1985; Padfield, 1996). To date, no research has provided any definitive evidence to support or refute either belief (Anderson, 1985; Ekerdt, Baden, Bosse, & Dibbs, 1983; Haynes, McMichael, & Tyroler, 1978; Herzog, House, & Morgan, 1991; Marmot & Shipley, 1996; Mein, Martikainen, Hemingway, Stansfeld, & Marmot, 2003; Ohrui, Matsui, He, Ebihara, & Sasaki, 2004; Quaade, Engholm, Johansen, & Moller, 2002; Rosenkoetter & Garris, 1998; Ross & Drentea, 1998; Schnurr, Lunney, Sengupta, & Spiro, 2005; Sorlie & Rogot, 1990).

The role of retirement and its effect on health and mortality is dependent on how retirement is defined and measured. In contrast to the ambiguous results of the relationship between early and on-time retirement as risk factors for illness, both ill-health and disability appear to be strong risk factors for retirement (Krause, Lynch, Kaplan, Cohen, Goldberg, & Salonen, 1997; Pransky, Benjamin, & Savageau, 2005;

Siebert, Rothenbacher, Daniel, & Brenner, 2001). Without considering health-related retirement it is possible to mistakenly assume that retirement is the risk factor. This systematic review addresses the following research question: “Does the research literature support the view that type of retirement is a risk factor for mortality?”

Methods

Research related to retirement and mortality was systematically reviewed adapting a Cochrane review protocol (Higgins and Green, Ed., 2006) and following Slavin’s (1995) ‘best evidence synthesis’ approach and the systematic review protocols of the Institute for Work and Health (IWH) (Brewer, VanEerd, Amick et al., 2006). The review team included six researchers from the United States, Canada and the United Kingdom. Web-based SRS, version 4.0 software (Mobius Analytics, 2009) was used for article organization, review, data extraction and tracking. Team members did not review or extract data from articles they had consulted on, authored or co-authored.

Eligibility Criteria

Studies were included if they: 1) were written in English; 2) were published or in-press in a peer-reviewed journal; 3) reported data from a longitudinal primary study (i.e., not a review or editorial); 4) measured retirement as an independent variable, main effect, co-variable or confounder; 5) did not combine retirement with unemployment status or “other” employment categorizations; and 6) measured either all-cause or cause-specific mortality as an outcome.

Literature Search

As of December 2008, no systematic reviews of this literature were identified. A preliminary literature review identified search terms covering three broad areas: 1)

retirement, 2) mortality/survival and 3) epidemiologic study methods. Search and exclusion terms were adapted for six electronic databases that index social, economic and health related journals published through 2008. The databases, search platforms and beginning coverage dates included: Academic Search Premier (via EBSCO) 1887, CINAHL (via OVID and EBSCO) 1982, EconLit (via OCLC FirstSearch) 1969, MEDLINE (via OVID) 1950, PsycInfo (via OVID) 1887, and Sociological Abstracts (via CSA) 1967. For all articles eligible for data extraction, we used the Scopus™ web-based database (Elsevier, 2007) to identify any additional articles 'cited by' or 'citing' the article that may have been overlooked or missed. Content area experts were also surveyed for potentially eligible articles. The complete search strategy is available from the first author.

Selection for relevance

First, title and abstract screening (TAS) was conducted to quickly identify and exclude non-relevant studies. Second, full text screening (FTS) was completed for the remaining studies. One review team member evaluated each article at each step. To reduce agreement bias, reviewers were assigned different articles for TAS and FTS.

To address potential bias due to a single reviewer conducting the TAS, an independent reviewer completed a quality control check by reviewing titles and abstracts of 5% (n=39) of the 758 excluded articles and 5% (n=11) of the 210 articles forwarded to FTS. Concordance was high and the team considered the quality of the TAS process acceptable.

Quality Assessment and Ranking

After FTS, articles were forwarded to Quality Assessment (QA) and Ranking

(QR) review. Prior to QA, the team developed 14 criteria to assess methodological quality and statistical validity. Following Brewer et al., (2006), the team decided on a three-point weighting scale ranging from: “important” (1 point) to “moderately important” (2 points) to “highly important” (3 points) (Table 1). A non-weighted exclusionary question (Table 1, Item 1) addressed the definition of retirement in each article. Grouping retirement with unemployment status or “other” employment categories was inadequate to assess the study question. Each article was independently reviewed by two team members who were required to reach consensus.

The QR for each article was based on a weighted sum of 13 quality criteria (highest score =21). This QR denominator was reduced by one for each “non applicable” answer. Each article received a QR by dividing the weighted score by the QR denominator and multiplying by 100. Articles were grouped into three categories (Appendix A) determined by consensus following the review methodology literature (Higgins & Green, 2006; Slavin, 1995): 1) high (90-100%), 2) medium-high (75-89%) and 3) medium-low (≤74%).

Data extraction

To retain only those studies with adequate validity to answer the research question, studies with medium-low quality (MLQ) rankings (≤74%) were excluded. Differences between medium-low (MLQ) and medium-high (MHQ) QR studies (Appendix A) varied. The main reasons for lower rankings were: 1) inappropriate use and/or description of statistical methods (MLQ=66%, 19/29 vs. MHQ=0%, 0/9); 2) lack of statistical adjustment for potential confounders (MLQ=62% 21/29 vs. MHQ=44% 4/9). Also, 44.8% (13/29) of the MLQ studies, but only 22% (2/9) of the MHQ studies, did not

compare similarly employed and/or retired populations. Thus, many MLQ studies did not address the healthy worker effect, when lower mortality is observed in employed populations when compared to the general population.

Full data extraction and evidence synthesis was completed on all studies in the "high" (n=4) and "medium-high" (n=9) categories using standardized data extraction questions (Appendix B). Two reviewers performed independent data extraction on each article. The data collected were used to build summary tables and to form the 'best evidence' synthesis basis for the team's conclusions. When studies presented multiple statistical analysis models adjusting for different confounders, data extraction is presented for the fully adjusted models only.

Evidence synthesis

The studies reviewed were heterogeneous and differed by country, study designs, exposure definitions, mortality outcomes and statistical methods used. This required a research synthesis approach using Slavin's (1995) 'best evidence synthesis' methodology. Based on quality ranking, quantity of evidence, and consistency among articles we used the criteria in Table 5 to classify evidence as strong, sufficient, mixed or insufficient (Brewer et al., 2006; Briss, Zaza, Pappaioanou et al., 2000; Slavin, 1995).

Results

We identified a total of 1,126 articles (Figure 1); 1,084 were excluded during TAS (n=897), FTS (n=149) and QA (n=38). Out of the 42 articles ranked, 29 articles were excluded based on their medium-low quality rankings. Thus, evidence synthesis was conducted on the remaining 13 articles (Table 2). These studies were published between 1976 and 2008 and covered the time period of 1953 to 2006. Cohort sample

sizes ranged from 1,235 (Olsen & Jeune, 1980) to 170,749 (Munch & Svarer, 2005); 54% of the studies had more than 12,000 individuals.

Table 3 shows the main study characteristics and illustrates the heterogeneous nature of the studies. The studies included mostly Caucasian men in both white and blue-collar occupations, and spanned over Asia/Middle-East, Europe and North America. Study designs were either prospective or retrospective cohort and employed and reported multiple statistical techniques: standardized mortality ratios, survival analysis with hazard ratios (HRs), or logistic regression with relative risks (RRs). All-cause mortality was measured in all studies and six studies provided additional cause-specific mortality. Study results are presented in Table 4 and evidence synthesis in Table 5.

Given our primary research question, “Does the research literature support the view that type of retirement is a risk factor for mortality?”, we first examined the general question about retirement as a mortality risk factor and then summarized evidence based on three specific types of retirement: 1) on-time (regular) retirement, 2) early retirement (not health-related) and 3) health-related retirement.

Considering *all types of retirement combined*, three high quality studies (Jeune, 1982; Olsen & Jeune, 1980; Tsai, Wendt, Donnelly, de Jong, & Ahmed, 2005) and five medium-high quality studies (Amick, McDonough, Chang, Rogers, Pieper, & Duncan, 2002; Bamia, Trichopoulou, & Trichopoulos, 2008; Morris, Cook, & Shaper, 1994; Pensola & Martikainen, 2004; Wagner, Berger, Flesch-Janys et al., 2006) found specified categories of retirees with higher risk when compared to either current employees or other retirees. Two studies, one high quality study (Litwin, 2007) and one

medium-high quality (Munch & Svarer, 2005), found mixed evidence. Three medium-quality studies (Arrich, Lalouschek, & Mullner, 2005; Collins & Redmond, 1976; Wen, Tsai, Gibson, & McClellan, 1984) found no increased risk. *These results suggest both strong and sufficient evidence that retirement (all types combined) is a risk factor for mortality.*

On-time retirement: One high quality study (Litwin, 2007) found on-time retirement to be associated with an increased risk of dying when compared to current employees. Medium-high quality studies found: higher mortality risk among both men and women when compared to non-retired workers (Amick et al., 2002); higher risk when compared to non-retired workers only among men (Munch & Svarer, 2005); lower risk when compared to the general population (Collins & Redmond, 1976; Wen et al., 1984); and, no evidence of association when compared to those still employed (Arrich et al., 2005). *These results suggest a mixed—and inconclusive—level of evidence neither for nor against on-time retirement as a risk factor for mortality.*

Early retirement: Two high quality studies showed contradictory results. When compared to on-time retirees, Tsai (2005), found an increased mortality risk for early retirees, while Litwin (2007) found no association. The medium-high quality studies results include: three studies (Arrich et al., 2005; Munch & Svarer, 2005; Wen et al., 1984) found no association; Munch (2005) and Wen (1984) found lower mortality risk when compared to their skilled/employed counterparts in both men and women; Arrich (2005) found an inconclusive association; two other studies (Bamia et al., 2008; Morris et al., 1994) reported higher mortality risk; Bamia (2008) found early retirees (≤ 65 years-old and already retired at study enrollment) to have higher all-cause mortality

when compared to those still employed at study enrollment; and, finally, Morris (1994) found higher mortality risk among retired male white-collar workers when compared to actively employed male white-collar workers. *These results suggest a mixed level of evidence against early retirement (not health-related) as a risk factor for mortality.*

Health-related retirement: Two of the high quality studies found that disability retirement was shown to increase the risk of dying when compared to current employees (Jeune, 1982; Olsen & Jeune, 1980). These results were consistent with the medium-high quality studies where disability retirees had a higher risk than those currently employed (Pensola & Martikainen, 2004) or other non-disability retirees (Wagner et al., 2006). *These results suggest a mixed level of evidence for health-related retirement as a risk factor for mortality.*

Discussion

Our review suggests that there is strong and sufficient evidence for considering all-type retirement as a risk factor for mortality. However, there is mixed evidence for on-time retirement, early retirement (not health related) and health-related retirement as risk factors for mortality.

These dissimilar findings are not surprising since retirement is commonly used as a general descriptor of employment status—a worker who has permanently stopped working. However, this definition is too broad and includes, at a minimum, three different conceptualizations of retirement. Moreover, research in this area is sparse and the lack of standardized measures of mortality related to retirement makes it difficult to synthesize.

Not only were different outcome measures used, but different exposure groups

and numerous operational definitions of retirement make results interpretation more difficult. We identified three main measures used to examine the relationship between retirement and mortality: relative risk, hazard rate and SMR. The use of SMR, for instance, may not be the best risk measure since SMRs are usually adjusted for age only and mortality rates of the general population are used as the comparison group. Both Wen (1984) and Collins (1976) showed the protective effects of retirement on mortality, but using the general population as the comparison group of a work-related population overlooks the healthy worker effect bias.

Because there is a mixed level of evidence for health-related retirement as a risk factor for mortality, special attention is needed to avoid misclassifying health-related retirees as early or on-time retirees. Also if ill-health and disability are strong risk factors for retirement, then it is necessary to differentiate between health and non-health related reasons of early and on-time retirement. This may help clarify the relationship between early/on-time retirement and mortality by controlling for possible confounding of the ill-health and disability risk factors.

The limited number of studies did not allow us to examine in detail the possible roles of gender, race and/or culture on retirement and mortality. The studies included in the review spanned nine countries over three continents with less than 50% including women and only one study adjusting for ethnicity. Retirement may represent something different for men and women, given different labor market experiences for women compared to men, including lower rates of pay for similar jobs, greater familial obligations outside work, and lower labor force attachment. A focus on how gender affects the relationship between retirement and health should be included in future

studies on the relationship between retirement and health.

Retirement is also a life transition that may be influenced by the social and institutional environment. While there were too few studies to examine the relationship between retirement and health by country, welfare state regime, or market economy orientation, these broader based structural factors may play a role in determining who is able to retire and the effect on health. For example the higher rate of health-related retirement in European countries compared to the United States and Canada may mean that the relationship between health-related retirement and health could vary substantially across country clusters. Further, health insurance is tied to employment for most working Americans and creates a selection pressure and pathway though which early retirement could influence health in the US that is not present in other high-income countries that have universal health insurance.

Clearly a gap exists in the current research. If ill health and disability are reasons why people retire, future research will need to identify employee health histories and health status prior to retirement measurements. Health may be a confounder in the relationship between retirement and mortality and retirement may not be a risk factor for mortality when pre-retirement health is considered. More research is needed to determine if health selection into retirement (i.e. people retire based on their health) is the driver of mortality post retirement or if the retirement transition itself is the risk factor.

We consider it important to continue to develop the retirement/mortality literature with an eye toward the complexity—and reality—of the multiple circumstances surrounding the exit of workers from the workforce. Regrettably, the lack of translation resources required the exclusion of 12 non-English language articles that may or may

not have been valuable to the evidence synthesis process. Research on retirement as a risk factor for mortality remains sparse so development and identification of the grey literature in this area may not be yet possible. Since no comprehensive systematic reviews were identified that addressed the retirement/mortality relationship, the review team decided to focus on the broader research question using the best evidence synthesis versus comparing specific effects using meta-analysis techniques.

The current peer-reviewed literature provides very few high quality studies on the effect of retirement on mortality. Given the large and increasingly growing retired population there is a critical need for more research in this area.

References

Amick, B. C.,3rd, McDonough, P., Chang, H., Rogers, W. H., Pieper, C. F., & Duncan, G. (2002). Relationship between all-cause mortality and cumulative working life course psychosocial and physical exposures in the United States labor market from 1968 to 1992. *Psychosomatic Medicine, 64*(3), 370-381.

Anderson, K. H. (1985). The effect of mandatory retirement on mortality. *Journal of Economics and Business, 37*(1), 81-88.

Arrich, J., Lalouschek, W., & Mullner, M. (2005). Influence of socioeconomic status on mortality after stroke: Retrospective cohort study. *Stroke, 36*(2), 310-314.

Bamia, C., Trichopoulou, A., & Trichopoulos, D. (2008). Age at retirement and mortality in a general population sample: The Greek EPIC study. *American Journal of Epidemiology, 167*(5), 561-569.

Biefang, S., Gerdes, N., Hoeltz, J., & Potthoff, P. (1990). Predictors of early retirement and focused assignment to medical rehabilitation. *Sozial-Und Praventivmedizin, 35*(3), 129-137.

Breeze, E., Fletcher, A. E., Leon, D. A., Marmot, M. G., Clarke, R. J., & Shipley, M. J. (2001). Do socioeconomic disadvantages persist into old age? Self-reported morbidity in a 29-year follow-up of the Whitehall study. *American Journal of Public Health, 91*(2), 277-283.

Brewer, S., VanEerd, D., Amick, B. C.,3rd, Irvin, E., Daum, K. M., Gerr, F. et al. (2006). Workplace interventions to prevent musculoskeletal and visual symptoms and disorders among computer users: A systematic review. *Journal of Occupational Rehabilitation, 16*(3), 325-358.

Breyer, F., & Kifmann, M. (2004). The German retirement benefit formula: Drawbacks and alternatives. *FinanzArchiv, 60*(1), 63-82.

Briss, P. A., Zaza, S., Pappaioanou, M., Fielding, J., Wright-De Aguero, L., Truman, B. I. et al. (2000). Developing an evidence-based guide to community preventive services--methods. The task force on community preventive services. *American Journal of Preventive Medicine, 18*(1 Suppl), 35-43.

Campbell, P. R. (1996). *Population projections for states by age, sex, race, and hispanic origin: 1995 to 2025* No. PPL-47) U.S. Bureau of the Census, Population Division.

Collins, J. F., & Redmond, C. K. (1976). The use of retirees to evaluate occupational hazards. *Journal of Occupational Medicine, 18*(9), 595-602.

Cutler, N. E. (1997). The false alarms and blaring sirens of financial literacy: Middle-agers' knowledge or retirement income, health finance, and long-term care. *Generations, 21*(2), 34-40.

Ekerdt, D. J., Baden, L., Bosse, R., & Dibbs, E. (1983). The effect of retirement on physical health. *American Journal of Public Health, 73*(7), 779-783.

Elsevier, B. V. (2007). *Scopus™.* www.scopus.com

Gallo, W. T., Bradley, E. H., Falba, T. A., Dubin, J. A., Cramer, L. D., Bogardus, S. T.,Jr et al. (2004). Involuntary job loss as a risk factor for subsequent myocardial infarction and stroke: Findings from the health and retirement survey. *American Journal of Industrial Medicine, 45*(5), 408-416.

Gebbie, K. M., Koplan, J. P., Fox, E., & Marks, J. S. (2005, The future of public health: What will it take to keep Americans healthy and safe? *Supplement to Managed Care, 14*(9)

Gertler, M. (1999). Government debt and social security in a life-cycle economy. *Carnegie-Rochester Conference Series on Public Policy, 50*, 61-110.

Haynes, S. G., McMichael, A. J., & Tyroler, H. A. (1978). Survival after early and normal retirement. *Journal of Gerontology, 33*(2), 269-278.

Henriksson, K. M., Lindblad, U., Agren, B., Nilsson-Ehle, P., & Rastam, L. (2003). Associations between unemployment and cardiovascular risk factors varies with the unemployment rate: The cardiovascular risk factor study in southern Sweden (CRISS). *Scandinavian Journal of Public Health, 31*(4), 305-311.

Herzog, A. R., House, J., & Morgan, J. (1991). Relation of work and retirement to health and well-being in older age. *Psychology and Aging, 6*(2), 202-211.

Higgins, J. P. T., & Green, S. (Eds.). (2006). *Cochrane handbook for systematic reviews of interventions 4.2.6 [updated September 2006]*. Chichester, UK: John Wiley & Sons, Ltd.

Jeune, B. (1982). Survival experience of semi-skilled disability pensioners in Denmark. *Scandinavian Journal of Social Medicine, 10*(3), 73-76.

Kasl, S. V. (1996). The influence of the work environment on cardiovascular health: A historical, conceptual, and methodological perspective. *Journal of Occupational Health Psychology, 1*(1), 42-56.

Kasl, S. V., & Jones, B. A. (2000). The impact of job loss and retirement on health. *Social Epidemiology,* 118-136.

Krause, N., Lynch, J., Kaplan, G. A., Cohen, R. D., Goldberg, D. E., & Salonen, J. T. (1997). Predictors of disability retirement. *Scandinavian Journal of Work, Environment & Health, 23*(6), 403-413.

Lewis, W. C., Caliendo, F., & Bowles, T. J. (2002). Sources of error in estimating the personal consumption offset in retirement. *Journal of Forensic Economics, 15*(1), 45-55.

Litwin, H. (2007). Does early retirement lead to longer life? *Ageing and Society, 27*(5), 739-754.

Marmot, M. G., & Shipley, M. J. (1996). Do socioeconomic differences in mortality persist after retirement? 25 year follow up of civil servants from the first Whitehall study. *BMJ, 313*(7066), 1177-1180.

Mein, G., Martikainen, P., Hemingway, H., Stansfeld, S., & Marmot, M. (2003). Is retirement good or bad for mental and physical health functioning? Whitehall II longitudinal study of civil servants. *Journal of Epidemiology and Community Health, 57*(1), 46-49.

Mobius Analytics, Ottawa, Ontario, Canada. *SRS 4.0,* (2009).

Moen, P. (1996). A life course perspective on retirement, gender, and well-being. *Journal of Occupational Health Psychology, 1*(2), 131-144.

Morris, J. K., Cook, D. G., & Shaper, A. G. (1994). Loss of employment and mortality. *BMJ, 308*(6937), 1135-1139.

Munch, J. R., & Svarer, M. (2005). Mortality and socio-economic differences in Denmark: A competing risks proportional hazard model. *Economics & Human Biology, 3*(1), 17-32.

Ohrui, T., Matsui, T., He, M., Ebihara, S., & Sasaki, H. (2004). Relation between retirement and subsequent health status in highly educated older men. *Journal of the American Geriatrics Society, 52*(12), 2145-2147.

Olsen, J., & Jeune, B. (1980). The mortality experience of early old-age and disability pensioners from unskilled- and semiskilled labour groups in Fredericia. *Scandinavian Journal of Social Medicine, 16* (Supplementum. 16), 50-52.

Padfield, A. (1996). Myths in medicine. Story that early retirement is associated with longevity is often quoted. *BMJ (Clinical Research Ed.), 312*(7046), 1611.

Pearlin, L. I., Schieman, S., Fazio, E. M., & Meersman, S. C. (2005). Stress, health, and the life course: Some conceptual perspectives. *Journal of Health & Social Behavior, 46*(2), 205-219.

Pensola, T., & Martikainen, P. (2004). Life-course experiences and mortality by adult social class among young men. *Social Science & Medicine, 58*(11), 2149-2170.

Pransky, G. S., Benjamin, K. L., & Savageau, J. A. (2005). Early retirement due to occupational injury: Who is at risk? *American Journal of Industrial Medicine, 47*(4), 285-295.

Quaade, T., Engholm, G., Johansen, A. M., & Moller, H. (2002). Mortality in relation to early retirement in Denmark: A population-based study. *Scandinavian Journal of Public Health, 30*(3), 216-222.

Rodin, J. (Ed.). (1987). *Personal control through the life course.* Abeles, Ronald P. (Ed). (1987). Life-span perspectives and social psychology. (pp. 103-119). xv, 177 pp. Hillsdale, NJ, England: Lawrence Erlbaum Associates, Inc.

Rosenkoetter, M. M., & Garris, J. M. (1998). Psychosocial changes following retirement. *Journal of Advanced Nursing, 27*(5), 966-976.

Ross, C. E., & Drentea, P. (1998). Consequences of retirement activities for distress and the sense of personal control. *Journal of Health & Social Behavior, 39*(4), 317-334.

Schnurr, P., Lunney, C., Sengupta, A., & Spiro, A. I. I. (2005). A longitudinal study of retirement in older male veterans. *Journal of Consulting and Clinical Psychology, 73*(3), 561-566.

Siebert, U., Rothenbacher, D., Daniel, U., & Brenner, H. (2001). Demonstration of the healthy worker survivor effect in a cohort of workers in the construction industry. *Occupational & Environmental Medicine, 58*(12), 774-779.

Slavin, R. E. (1995). Best evidence synthesis: An intelligent alternative to meta-analysis. *Journal of Clinical Epidemiology, 48*(1), 9-18.

Sorlie, P. D., & Rogot, E. (1990). Mortality by employment status in the national longitudinal mortality study. *American Journal of Epidemiology, 132*(5), 983-992.

Streib, G. F., & Schneider, C. J. (1971). Introduction: Demography and retirement. *Retirement in American society: Impact and process* (pp. 1-8). Ithaca, NY: Cornell University Press.

Sweeney, M. H., Walrath, J., & Waxweiler, R. J. (1985). Mortality among retired fur workers. dyers, dressers (tanners) and service workers. *Scandinavian Journal of Work, Environment & Health, 11*(4), 257-264.

Tsai, S. P., Wendt, J. K., Donnelly, R. P., de Jong, G., & Ahmed, F. S. (2005). Age at retirement and long term survival of an industrial population: Prospective cohort study. *BMJ, 331*(7523), 995-998.

vanAmelsvoort, L. G., Kant, I. J., Bultmann, U., & Swaen, G. M. (2003). Need for recovery after work and the subsequent risk of cardiovascular disease in a working population. *Occupational & Environmental Medicine, 60*(Suppl 1), 83-87.

Virkkunen, H., Kauppinen, T., & Tenkanen, L. (2005). Long-term effect of occupational noise on the risk of coronary heart disease. *Scandinavian Journal of Work, Environment & Health, 31*(4), 291-299.

Wagner, N. L., Berger, J., Flesch-Janys, D., Koch, P., Kochel, A., Peschke, M. et al. (2006). Mortality and life expectancy of professional fire fighters in Hamburg, Germany: A cohort study 1950-2000. *Environmental Health: A Global Access Science Source, 5*, 27.

Wen, C. P., Tsai, S. P., Gibson, R. L., & McClellan, W. A. (1984). Long-term mortality of oil refinery workers. II. Comparison of the experience of active, terminated and retired workers. *Journal of Occupational Medicine, 26*(2), 118-127.

Figure 1. Flowchart of systematic review process

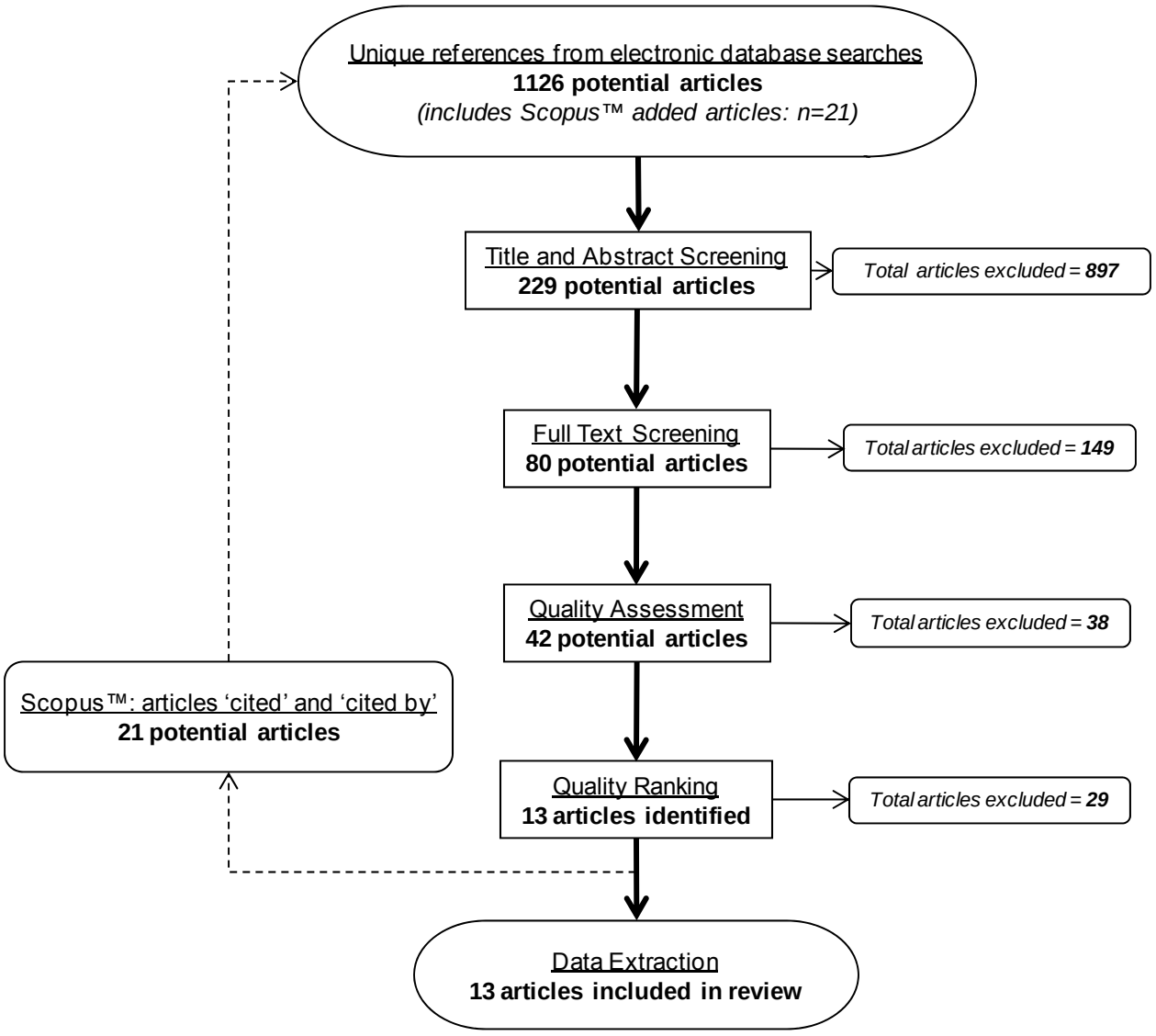

Table 1. Quality assessment questions, exclusionary response and weights

	Quality Assessment Question	***Weights***
1.	Is retirement (or type of retirement) grouped together with non-retirement related categories?	Yes = Exclude
2.	The primary research question/objective is clearly stated.	Yes = 1
3.	Is the primary research question/objective related to the systematic review study question that…type of retirement is a risk factor for mortality?	Yes = 2
4.	Were study sample methods (including sample size, inclusion/exclusion criteria and power) adequately described?	Yes = 2
5.	Was non-response to participation in the study addressed and/or adequately described?	Yes = 1
6.	Is retirement the primary exposure or main independent variable in the study?	Yes = 2
7.	Is retirement a main effect, co-variable, confounder or interaction in the study?	Yes = 1
8.	Is mortality a measured outcome in the study? If cause-specific is selected, enter the cause(s) in the text box.	Yes = 1
9.	Did the study measure retirement (exposure) before mortality (outcome)?	Yes = 3
10.	Is the comparison group (or reference group) appropriate? (i.e. does it make sense?)	Yes = 1
11.	Did the study make comparisons between similarly employed/retired populations?	Yes = 1
12.	Were covariates/potential confounders for mortality (e.g. gender, age, pre-existing health conditions) appropriately used to adjust or stratify the analysis and/or adequately described?	Yes = 2
13.	Was loss to follow-up appropriately addressed and/or adequately described in the study?	Yes = 1
14.	Were statistical methods appropriately used and/or adequately described to examine the retirement/mortality relationship?	Yes = 3

Table 2. Study Descriptions

		Author, year	Primary Research Question/Objective	Time Period (years) Study Location Study Design	Sample Size (% Female)	Employment Classifications - Definitions *(see notes below)*
Quality Ranking	High	Jeune, 1982	Estimate the survival prognosis of semi-skilled disability pensioners.	1975 - 1978 Denmark Retrospective Cohort	4,439 (0%)	1. **High disability** 2. **Intermediate disability** 3. **Low disability** 4. **Employed**
		Litwin, 2007	Address the association between early retirement and seven-year all-cause mortality in a sample of 2,374 older Jewish Israelis.	1997 - 2004 Israel Prospective Cohort	2,374 (39.2%)	1. **Still at work** - not retired 2. **Left work young** - before age 50 3. **Early retirement** - women age 50-59; men age 60-64 4. **On time retirement** - women age 60+; men age 65+ 5. **Missing** - failed to date exit from work
		Olsen, 1980	Compare mortality rates of male pensioners to a matched reference group of employed workers from the same union.	1969 - 1979 Denmark Retrospective Cohort	1,235 (0%)	1. **Disability/early old-age pension** - received between 10/1/69 - 9/30/73 2. **Active worker** - present at work 4/1/71 and alive on 9/30/73
		Tsai, 2005	Assess whether there is any survival advantage of early retirement among employees of the petrochemical industry in the United States who retired at 55, 60, and 65	1973 - 2003 United States Prospective Cohort	26,781 (11%)	1. **Retired at 55** 2. **Retired at 60** 3. **Retired at 65** 4. **Working at 55** 5. **Working at 60**
Quality Ranking	Medium-High	Amick, 2002	A person's lifetime exposure to psychosocial work conditions was modeled over the working life course, and its relationship to mortality was assessed in a representative sample of U.S. workers.	1968 - 1992 United States Prospective Cohort	25,413 (55.1%)	1. **Retired** - self-report for the year preceding the current interview year 2. **Working** - self-report of working[a] in the past year 3. **Unemployed** - self-reported unemployment status
		Arrich, 2005	Investigate the association between socioeconomic status and mortality of patients with acute ischemic stroke and transient ischemic attack.	1998 - 2002 Austria Prospective Cohort	3,607 (47%)	1. **Currently unemployed** - at the time of the event 2. **Working in own household** - at the time of the event 3. **Retired early** - before normal retirement age 4. **Retired** - women = age 60; men = age 65
		Bamia, 2008	Determine whether early retirement is a risk factor for all-cause and cause-specific mortality in apparently healthy retirees.	1994 - 2006 Greece Prospective Cohort	16,827 (47%)	1. **Employed** - at enrollment in the study 2. **Early retired** - retired at enrollment in the study and before age 65
		Collins, 1976	Describe what would occur in a large scale historical study of steelworkers if retirees only were used for mortality findings instead of all workers in the industry.	1953 - 1966 United States Prospective Cohort	58,828 (0%)	1. **Retirees over age 65**[b] 2. **Nonretirees over age 65 who left plant before 65**[c]

Notes:

a. full time, part-time, or temporary; annual working hours >500 hours or individual labor income was >$1000

b. management=age ≥65; union=age≥ 65 and minimum 15 years at the company

c. left plant after usual retirement age, still employed, died while employed

Table 2 (continued). Study Descriptions

		Author, year	Primary Research Question/Objective	Time Period (years) Study Location Study Design	Sample Size (% Female)	Employment Classifications - Definitions *(see notes below)*
Quality Ranking	Medium-High	Morris, 1994	Assess the effect of unemployment and early retirement on mortality in a group of middle aged British men using measures of health and health related behavior made before the loss of employment.	1979 - 1990 United Kingdom Prospective Cohort	6,191 (0%)	1. **Employed full time** - continuously employed during follow-up 2. **Retired early for reasons other than illness**
		Munch, 2005	Describe the association between socio-economic status and mortality at the individual level.	1992 - 1997 Denmark Prospective Cohort	170,749 (50.5%)	1. **Early retirement** - at age 60 2. **Retired** - through all the years 1988, 1992–1997
		Pensola, 2004	Quantify the contribution of living conditions in the parental home and life-events and trajectories in youth to adult social class differences in mortality from various causes of death.	1970 - 1998 Finland Prospective Cohort	186,408 (0%)	1. **Steady employment** - up to end of 1990, with the exception of national service 2. **Short unemployment** - <6 months during 1986–90 or one spell at the time of the census 3. **Long unemployment** - ≥6 months during 1986–90, or repeated at the time of ≥2 censuses 4. **Fragmental employment** - occasional exclusion[d] from labor force 5. **Retired on disability** - men on disability pension
		Wagner, 2006	Establish the life expectancy and standardized mortality ratios of firefighters of the Fire Department of the City of Hamburg, Germany compared to Hamburg and the national reference population with special emphasis on disentangling the suspected strong healthy worker effect in this cohort from the effects of potential chemical exposures and heavy work load.	1950 - 2000 Germany Retrospective Cohort	4,557 (0%)	1. **Dead** 2. **Active firefighter**- full-time professional employees 3. **Left by own request** - left the department for instance to move to a different city 4. **Early retirement** - left for health reasons/disability 5. **Regular retirement**
		Wen, 1984	Present the mortality experience of active, terminated and retired groups from a large refinery cohort.	1937 - 1978 United States Prospective Cohort	12,526 (0%)	1. **Active** - employed during the study 2. **Terminated** - left employment with no further financial linkage to the company 3a. **Regular retired** - at or after age 65 3b. **Early retired-regula**r - at 55[e]; at 50[f]; before 65[g] with length-of-service criteria 3c. **Early retired-disability** - 15 years of service + medical disability (initiated in 1957)

Notes:

d. other than unemployment, retirement, or education

e. between 1944-1963

f. between 1963-1974

g. 1975-present

Table 3. Study Characteristics

	Quality Ranking												
	High				Medium-High								
Author, year	Jeune, 1982	Litwin, 2007	Olsen, 1980	Tsai, 2005	Amick, 2002	Arrich, 2005	Bamia, 2008	Collins, 1976	Morris, 1994	Munch, 2005	Pensola, 2004	Wagner, 2006	Wen, 1984
Study Location													
Europe	X		X			X	X		X	X	X	X	
Middle-East		X											
United States				X	X			X					X
Study Design													
Prospective Cohort		X		X	X	X	X	X	X	X	X		X
Retrospective Cohort	X		X									X	
Study Demographics													
Males Only	X		X					X	X		X	X	X
Males and Females		X		X	X	X	X			X			
Caucasian Only	*	X	*	*		*	X		*	*	*	*	X
Multiple Ethnicities					X[a]			X[b]					
Retirement Data Source													
Census data											X		
Employee/retiree records				X				X					X
Municipal records	X		X							X		X	
Self-report		X			X	X	X		X				
Analysis Type													
Logistic Regression					X						X		
Standardized Mortality Ratio (SMR)								X			X		X
Survival Analysis	X	X	X	X		X	X		X	X		X	
Mortality Outcome(s)													
All-cause mortality	X	X	X	X	X	X	X	X	X	X	X	X	X
Cause-specific mortality							X	X	X	X	X		X
Mortality Outcome Measure													
Hazard ratio		X		X	X	X	X			X			
Relative Risk	X		X						X		X	X	
Standardized Mortality Ratio (SMR)								X				X	X
Occupational Category													
White-collar				X					X		X		
Blue-collar	X			X		X		X	X		X	X	
White/Blue-collar Combined		X	X		X		X			X			X

Note: * race/ethnicity of study population not explicitly stated
a. ethnicities included white and black
b. ethnicities included white and non-white

Table 4. Study results and interpretation by quality ranking, author and exposure/referent groups

Quality Ranking	Author, year	Exposure(E)/Referent(R) Groups	Number of Events	Measure of Association; 95% CI; p value	Statistical Adjustment for Covariables/ Confounders	Interpretation
High	Jeune, 1982	E1. All disability pensioners (*n*=1,353) R1. Employed (*n*=1,353)	E1. 234 deaths R1. 41 deaths	E1. Relative death rate = 1.85; 95% CI NP R1. Relative death rate = 0.28; 95% CI NP **RR (Crowley method) = 6.8; p<0.05**[a,b]	Age	Disability pensioners have 6.8 times the risk of dying than those currently employed. **YES--Health-related retirement is a risk factor for mortality**
	Litwin, 2007	E1a. Still at work (*n*=486) E1b. Left work young (*n*=164) E1c. Early retirement (*n*=540) E1d. Missing (*n*=219) R1. On time retirement (*n*=965)	NP	E1a. **HR = 0.65; 95% CI 0.48-0.88; p<0.01** E1b. HR = 0.75; 95% CI 0.48-1.19 E1c. **HR = 0.93; 95% CI 0.74-1.16** E1d. HR = 1.17; 95% CI 0.91-1.51	Reason for retirement Gender Age Income Education Diagnosed illness	Those currently employed are 35% less likely to die than those who retire on-time. Although it appears that leaving work while young or retiring early offers some decreased risk of dying, the 95% confidence intervals which include 1.0 do not support the association. **YES--On-time retirement is a risk factor for mortality** **NO--Early retirement is not a risk factor for mortality**
	Olsen, 1980	E1. Disability pensioners (*n*=64) R1. Active workers (*n*=121)	E1. 13 deaths R1. 4 deaths	**RR = 7.2; p<0.001**	NP	Disability pensioners have 7.2 times the risk of dying than active workers. **YES--Health-related retirement is a risk factor for mortality**
	Tsai, 2005	E1. Retired at 55 (*n*=839) E2. Retired at 60 (*n*=1,929) R1-2. Retired at 65 (*n*=900)	E1. 173 deaths E2. 581 deaths R1. 462 deaths	E1. **HR = 1.37; 95% CI 1.09-1.73** E2. HR = 1.06; 95% CI 0.92-1.22	Gender SES Calendar year of entry to study	Employees that retired at age 55 had a 37% increase in mortality when compared to employees that retired at age 65. **YES--Early retirement is a risk factor for mortality**

Note: a. meaningful measures of association and interpretations are highlighted in **bold**

b. statistically significant effects are underlined

Abbreviations: NP = not provided
HR = hazard ratio
RR = relative risk

Table 4 (continued). Study results and interpretation by quality ranking, author and exposure/referent groups

Quality Ranking	Author, year	Exposure(E)/Referent(R) Groups	Number of Events	Measure of Association	Statistical Adjustment for Covariables/ Confounders	Interpretation
Medium-High	Amick, 2002	5-year lag (Karasek Job Strain) E1a. Retired (*n*=7,591) E1b. Age x retired (*n*=7,591) 10-year lag (Karasek Job Strain) E2a. Retired (*n*=7746) E2b. Age x retired (*n*=7746) 5-year lag (Job Strain Quotient) E3a. Retired E3b. Age x retired 10-year lag (Job Strain Quotient) E4a. Retired E4b. Age x retired R1-4. Not retired	5-year lag 10,008 retirements 571 deaths 10-year lag 10,959 retirements 726 deaths	5-year lag (Karasek Job Strain) E1a. **HR = 5.92; 95% CI 3.40-10.30; p<0.05**[a,b] E1b. **HR = 0.92; 95% CI 0.90-0.94; p<0.05** 10-year lag (Karasek Job Strain) E2a. **HR = 2.85; 95% CI 1.56-5.11; p<0.05** E2b. **HR = 0.95; 95% CI (0.93-0.97; p<0.05** 5-year lag (Job Strain Quotient) E3a. **HR = 5.90; 95% CI 3.39-10.25; p<0.05** E3b. **HR = 0.92; 95% CI 0.90-0.94; p<0.05** 10-year lag (Job Strain Quotient) E4a. **HR = 2.83; 95% CI 1.58-5.08; p<0.05** E4b. **HR = 0.95; 95% CI 0.93-0.97; p<0.05**	Psychosocial work conditions Age Black race/ethnicity Sex Study year Family income Family size Not working Age x black Age x retired Baseline disability	When compared to those NOT retired, retirees were 5.9 times as likely to die in the 5 year post retirement transition period. When compared to those NOT retired, retirees were 2.8 times as likely to die in the 10 year post retirement transition period. **YES--On-time retirement is a risk factor for mortality**
	Arrich, 2005	E1a. Early Retired (*n*=328) E1b. Retired (*n*=1,478) R1. Employed (*n*=512)	E1a. 57 deaths E1b. 351 deaths R1. 18 deaths	E1a. **HR = 1.76; 95% CI 0.93-3.36** E1b. **HR = 1.45; 95% CI 0.79-2.67**	SES Age Sex Stroke severity History of stroke Ischemic heart disease Hypertension Elevated plasma lipids Diabetes Peripheral vascular disease Smoking status	When compared to those employed, those that retired and retired early showed an increased risk of dying, however 95% confidence intervals for both measures included 1.0 and offer no conclusive evidence to support the association. **NO--On-time retirement is not a risk factor for mortality** **NO--Early retirement is not a risk factor for mortality**

Note: a. meaningful measures of association and interpretations are highlighted in **bold**

b. statistically significant effects are <u>underlined</u>

Abbreviations: HR = hazard ratio
RR = relative risk

Table 4 (continued). Study results and interpretation by quality ranking, author and exposure/referent groups

		Author, year	Exposure(E)/Referent(R) Groups	Number of Events	Measure of Association	Statistical Adjustment for Covariables/ Confounders	Interpretation
Quality Ranking	Medium-High	Bamia, 2008	E1. Early Retired *(n=3,874)* R1. Employed *(n=12,953)*	E1. 404 deaths R1. 215 deaths	E1. **HR = 1.51 ; 95% CI 1.16-1.98; p=0.002**[a, b]	Age at enrollment Education Smoking status Waist-to-hip ratio Physical activity Body mass index Total energy intake Ethanol intake --- Stratified by gender	When compared to those still employed at study enrollment, early retirees (persons that were ≤ age 65 and already retired at study enrollment) in the study had a 51% increase in all-cause mortality. **YES--Early retirement is a risk factor for mortality**
		Collins, 1976	E1. Retirees over 65 (*n*=9,688) E2. Nonretirees over age 65 (*n*=391) R1. Allegheny County males (*n*=NP)	E1. 2637 deaths E2. 97 deaths	E1. **SMR = 0.851; p<0.05** E2. **SMR = 1.769 ; p<0.05**	Age (men > age 65 only)	Retirees over age 65 were 15% less likely to die than their community counterparts. **NO--On-time retirement is not a risk factor for mortality**
		Morris, 1994	E1. Retired early not due to illness (*n*=479) R1. Continuously employed (*n*=4,112) E2a. Retired early not due to illness--Manual workers E2b. Retired early not due to illness--Non-manual workers R2a. Continuously employed--Manual workers R2b. Continuously employed--Non-manual workers	E1-2. 59 deaths R1-2. 174 deaths	E1. **RR = 1.86; 95% CI 1.34-2.59** E2a. **RR = 1.57; 95% CI 1.00-2.47** E2b. **RR = 2.51; 95% CI 1.50-4.19**	Age Town Social class Smoking Alcohol intake Pre-existing disease	Those that retire early (not due to illness) are 86% more likely to die than those employed. White collar workers (non-manual) that retire early (not due to illness) are 2.5 times as likely to die as those white collar workers who are employed. **YES--Early retirement is a risk factor for mortality**

Note: a. meaningful measures of association and interpretations are highlighted in **bold**

b. statistically significant effects are underlined

Abbreviations: HR = hazard ratio

RR = relative risk

SMR = standardized mortality ratio

Table 4 (continued). Study results and interpretation by quality ranking, author and exposure/referent groups

		Author, year	Exposure(E)/Referent(R) Groups	Number of Events	Measure of Association	Statistical Adjustment for Covariables/ Confounders	Interpretation
Quality Ranking	Medium-High	Munch, 2005	E1a. Early retirement-women (*n*=NP) E1b. Retired-women (*n*=NP) R1. Skilled-women (*n*=NP) E1a. Early retirement-men (*n*=NP) E1b. Retired-men (*n*=NP) R1. Skilled-men (*n*=NP)	NP	E1a. **HR = -0.82[c] (-55.96%[d]); p=0.05**[a, b] E1b. HR = -0.01[c] (-0.995%[d]); p>0.05 E2a. **HR = -0.22[c] (-19.75%[d]); p=0.05** E2b. **HR = 0.22[c] (24.61%[d]); p=0.05**	City Education Skill level Sector Homeownership	When compared to female skilled workers, women that retire early have a 56% decrease in mortality rate. When compared to male skilled workers, men that retire early have about a 20% decrease in mortality rate. When compared to male skilled workers, men that are retired have about a 25% increase in mortality rate. **YES--On-time retirement is a risk factor for mortality (*men only)*** **NO--Early retirement is not a risk factor for mortality**
		Pensola, 2004	E1. Retired on disability (*n*=4,767) R1. Steady employed (*n*=139,716)	E1. 422 deaths R1. 1493 deaths	**<u>RR = 4.72; p<0.05</u>**	Age Social class Parental class Family type Number of siblings Language Region Education Marital path Early parenthood Employment path	Disability retirees have 4.7 times the risk of dying than those steadily employed. **YES--Health-related retirement is a risk factor for mortality**

Note: a. meaningful measures of association and interpretations are highlighted in **bold**

b. statistically significant effects are <u>underlined</u>

c. hazard rate coefficient

d. % change = 100 x (exp(β)-1)

Abbreviations: NP = not provided

HR = hazard ratio

RR = relative risk

Table 4 (continued). Study results and interpretation by quality ranking, author and exposure/referent groups

		Author, year	Exposure(E)/Referent(R) Groups	Number of Events	Measure of Association	Statistical Adjustment for Covariables/ Confounders	Interpretation
Quality Ranking	Medium-High	Wagner, 2006	E1a. Early retirement-disability (*n*=469) E1b. Regular retirement (*n*=1,419) R1. German population (*n*=NP) E2. Early retirees-disabled (*n*=NP) R2. All other retirees (*n*=NP)	E1b. 131 deaths E1c. 644 deaths E2. NP R2. NP	E1a. SMR = 1.35; 95% CI 1.13-1.60[a, b] E1b. SMR = 0.79; 95% CI 0.73-0.85 E2. **RR = 1.71; 95% CI 1.18-2.50**	Age-specific SMR Rank group Age at employment Year of employment Duration of employment	Firefighters that retired early on disability were 1.7 times more likely to die than all other firefighter retirees. **YES--Health-related retirement is a risk factor for mortality**
		Wen, 1984	E1a. Active (*n*=12,526) E1b. Terminated (*n*=6,199) E1c. Retired (*n*=2,837) E2a. Retired-regular (*n*=1,053) E2b. Retired-early (*n*=1,784) R1-2. White males in the US by cause of death (n=NP)	E1a. 855 deaths E1b. 1306 deaths E1c. 1280 deaths E2a. 246 deaths E2b. 485 deaths	E1a. SMR = 0.68; 95% CI 0.64-0.73; p<.01 E1b. SMR = 1.04; 95% CI 0.99-1.10 E1c. **SMR = 0.89; 95% CI 0.84-0.94; p<.01** E2a. **SMR = 0.87; 95% CI 0.76-0.98; p<.05** E2b. **SMR = 0.89; 95% CI 0.82-0.98; p<.05**	Cause-specific mortality Age-specific mortality Calendar time-specific mortality	Retirees were 11% less likely to die than the general US white male population. Among those that retired, regular retirees were 13% less likely to die than the general US white male population. Among those that retired, early retirees were 11% less likely to die than the general US white male population. **NO--On-time retirement is not a risk factor for mortality** **NO--Early retirement is not a risk factor for mortality**

Note: a. meaningful measures of association and interpretations are highlighted in **bold**

b. statistically significant effects are underlined

Abbreviations: NP = not provided
RR = relative risk
SMR = standardized mortality ratio

Table 5. Evidence synthesis*

		Author, year	Is retirement a risk factor for mortality?	Is type of retirement a risk factor for mortality?		
				On-time	Early	Health-related
Quality Ranking	High	Jeune, 1982	**Yes**			**Yes**
		Litwin, 2007	Mixed	Yes	**No**	
		Olsen, 1980	**Yes**			**Yes**
		Tsai, 2005	**Yes**		Yes	
Quality Ranking	Medium-High	Amick, 2002	**Yes**	Yes		
		Arrich, 2005	No	No	**No**	
		Bamia, 2008	**Yes**		Yes	
		Collins, 1976	No	No		
		Morris, 1994	**Yes**		Yes	
		Munch, 2005	Mixed	Yes	**No**	
		Pensola, 2004	**Yes**			**Yes**
		Wagner, 2006	**Yes**			**Yes**
		Wen, 1984	No	No	**No**	
Evidence Synthesis Results			Strong & Sufficient Evidence FOR	Mixed Evidence (inconclusive)	Mixed Evidence AGAINST	Mixed Evidence FOR

* Following guidelines set forth by Brewer et al. (2006), **strong** evidence in this review requires a minimum of 3 high quality studies to converge on the same finding; **sufficient** evidence requires convergence of 7 medium-high to high studies; and **mixed** evidence requires a minimum of 3 medium-high to high studies.

Appendix A. Methodological quality assessment ordered by quality ranking and author

Criteria #	2	3	4	5	6	7	8	9	10	11	12	13	14	
Criteria Weight	1	2	2	1	2	1	1	3	1	1	2	1	3	
High Quality Ranking														**Quality Ranking**
Jeune, 1982	1	2	2	N/A	2	1	1	3	1	1	2	N/A	3	**100%**
Litwin, 2007	1	2	2	N/A	2	1	1	3	1	1	2	N/A	3	**100%**
Olsen, 1980	1	2	2	N/A	2	1	1	3	1	1	2	N/A	3	**100%**
Tsai, 2005	1	2	2	N/A	2	1	1	3	1	1	2	N/A	3	**100%**
Criteria Met	**4/4**	**4/4**	**4/4**	**N/A**	**4/4**	**4/4**	**4/4**	**4/4**	**4/4**	**4/4**	**4/4**	**NA**	**5/5**	
% Criteria Met	**100%**	**100%**	**100%**	**N/A**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**N/A**	**100%**	
Medium-High Quality Ranking														
Bamia, 2008	1	2	2	N/A	2	N/A	1	3	1	1	0	1	3	**89%**
Collins, 1976	1	2	2	N/A	2	N/A	1	3	1	0	0	1	3	**84%**
Amick, 2002	1	0	2	1	0	1	1	3	1	1	2	1	3	**81%**
Morris, 1994	1	2	2	0	2	N/A	1	3	1	1	0	0	3	**80%**
Pensola, 2004	1	0	2	N/A	0	1	1	3	1	1	2	1	3	**80%**
Wagner, 2006	1	0	2	N/A	0	1	1	3	1	1	2	1	3	**80%**
Arrich, 2005	1	0	2	N/A	0	1	1	3	1	1	2	N/A	3	**79%**
Wen, 1984	1	2	2	N/A	2	1	1	3	0	0	0	N/A	3	**79%**
Munch, 2005	1	0	2	1	0	1	1	3	1	1	2	0	3	**76%**
Criteria Met	**9/9**	**4/9**	**9/9**	**2/3**	**4/9**	**6/6**	**9/9**	**9/9**	**8/9**	**7/9**	**5/9**	**5/7**	**9/9**	
% Criteria Met	**100%**	**44%**	**100%**	**67%**	**44%**	**100%**	**100%**	**100%**	**89%**	**78%**	**56%**	**71%**	**100%**	
Medium-Low Quality Ranking														
Collins, 1978	1	0	2	N/A	0	N/A	1	3	1	0	2	1	3	**74%**
Haynes, 1977	1	2	2	N/A	2	1	1	3	1	1	0	N/A	0	**74%**
Haynes, 1978	1	2	2	N/A	2	1	1	3	1	1	0	N/A	0	**74%**
Sweeney, 1985	0	2	2	N/A	0	1	1	3	0	0	2	N/A	3	**74%**
McCoy, 1994	1	2	2	N/A	2	N/A	1	3	1	1	0	N/A	0	**72%**
Boaz, 1990	1	2	0	1	0	1	1	3	1	1	0	1	3	**71%**
Ostamo, 2001	1	0	2	1	0	1	1	3	1	1	0	1	3	**71%**
Wolfson, 1993	1	0	2	1	0	1	1	3	1	1	0	N/A	3	**70%**
Baker, 1982	1	2	2	N/A	2	1	1	3	1	0	0	N/A	0	**68%**
McMahan, 1955	1	2	2	N/A	2	1	1	3	0	1	0	N/A	0	**68%**
Wong, 1985	0	0	2	N/A	0	1	1	3	1	0	2	N/A	3	**68%**
Herttua, 2008	1	0	2	N/A	0	1	1	0	1	1	2	N/A	3	**63%**
May, 2002	1	0	2	1	0	0	1	3	1	1	2	1	0	**62%**
Quaade, 2002	1	2	2	0	2	N/A	1	0	1	0	0	0	3	**60%**
Rushing, 1992	1	0	2	1	0	1	1	3	0	0	2	1	0	**57%**
Enterline, 1972	1	0	2	N/A	2	N/A	1	3	0	1	0	N/A	0	**56%**
Kingson, 1982	0	2	0	N/A	2	N/A	1	3	1	1	0	N/A	0	**56%**
Gamble, 2000	0	2	2	0	2	N/A	1	3	1	0	0	0	0	**55%**
Beck, 1981	1	0	2	N/A	2	1	0	3	1	0	0	N/A	0	**53%**
Lidgren, 2007	1	0	2	N/A	0	1	1	0	1	1	0	N/A	3	**53%**
Studznski, 2003	1	2	2	0	0	0	1	3	1	1	0	0	0	**52%**
Weiland, 1996	1	0	2	1	0	1	1	3	1	0	0	1	0	**52%**
Saarela, 2002	1	0	2	N/A	0	1	0	0	1	0	2	0	3	**50%**
Enterline, 1975	1	0	0	N/A	2	N/A	1	3	1	1	0	0	0	**47%**
Pavia, 2005	1	0	2	N/A	0	1	1	0	1	1	2	N/A	0	**47%**
Pinto, 1977	1	2	0	N/A	2	N/A	1	3	0	0	0	0	0	**47%**
Clarke, 1972	1	0	2	N/A	2	N/A	0	0	1	1	0	N/A	0	**39%**
Thomas, 1985	1	0	0	N/A	0	1	1	0	1	0	0	N/A	0	**21%**
Heikkinen, 1992	0	0	0	0	0	0	1	0	0	0	0	N/A	0	**5%**
Criteria Met	**24/29**	**12/29**	**23/29**	**6/10**	**13/27**	**17/20**	**26/27**	**21/29**	**23/29**	**16/29**	**8/29**	**6/12**	**10/29**	
% Criteria Met	**83%**	**41%**	**79%**	**60%**	**45%**	**85%**	**90%**	**72%**	**79%**	**55%**	**28%**	**50%**	**34%**	

Appendix B. Data extraction questions

1.	Write the last name of the first author and the year of publication.
2.	State the primary research question(s)/objective(s) related to the systematic review study question.
3.	State the primary hypothesis related to the systematic review study question that
4.	State additional hypotheses related to the systematic review study question that are not listed in question #3.
5.	In what country was the study conducted?
6.	In what region/province was the study conducted?
7.	In what state was the study conducted?
8.	In what city was the study conducted?
9.	What is the overall time period covered by the study?
10.	What is the study design? (Select only one)
11.	What is the main statistical analysis method used? (Select only one)
12.	What is the overall study sample size and description?
13.	List the detailed characteristics of the study population/study participants/subjects.
13a.	Sample Size
13b.	Follow-up Time Period
13c.	Mean/Median Age (report stated measure of central tendency and its value to one decimal place)
13d.	Standard Deviation of Age (report to one decimal place)
13e.	Age Range
13f.	Number of Males
13g.	Number of Females
13h.	Ethnicities Included (separate by comma)
13i.	Percent Non-White (report as a number to one decimal place)
13j.	Occupation
13k.	Percent Blue-Collar Workers (manual or technical laborer -report as a number to one decimal place)
13l.	Mean/Median of Employment Tenure—years employed at job (report stated measure of central tendency and its value to one decimal place)
13m.	Standard Deviation of Employment Tenure (report to one decimal place)
13n.	Employment Tenure Range (include the unit of time -- days/months/years)
14.	Describe any additional notable/unique characteristics of the study population/study participants/subjects not listed above in Q13.
15.	For each data type, list the associated data source.
16.	List the inclusion criteria described in the study.
17.	List the exclusion criteria described in the study.
18.	List each employment classification used in the study.
19.	List associated definition of each employment classification used in the study.
20.	List the criteria for handling those study participants which are lost to follow-up.
21.	Select the mortality outcome measured in the study.
22.	List the location of data in the article.
23.	List/describe each exposure/referent group related to the systematic review study question.
24.	List the associated number of people for each exposure/referent group.
25.	List the mean of age for each exposure/referent group.
26.	List the SD of age for each exposure/referent group.
27.	List the age range for each exposure/referent group.
28.	List the number of females for each exposure/referent group.
29.	List/describe each exposure/referent group related to the systematic review study question that (from question #23).
30.	List the number of events for each exposure/referent group.
31.	List the outcome measure for each exposure/referent group.
32.	List the measure of association value for each exposure/referent group.
33.	List the 95% confidence interval/p-value for each exposure/referent group.
34.	List the adjustment for each exposure/referent group.
35.	Describe any additional outcome measures and their associated 95% CIs and p-values not listed in Q29 – Q34 above.
36.	Describe the significant differences in covariates/confounders between those that participated in the study vs. those that were lost to follow-up.
37.	State the overall conclusion(s) of the study.
38.	Please provide YOUR interpretation of the study results plus any noteworthy strengths and limitation of the study. You can also provide any comments, remarks or insights on the study/findings, comparability of the exposure/referent groups or enter other information that is unique about the study that may not be adequately captured elsewhere on the Data Extraction form.
39.	Check the names of both Data Extraction reviewers for this study.
40.	Is this the consensus–final–version of the Data Extraction form?