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ORIGINAL INVESTIGATION

Complex health problems and mortality among the oldest old in Sweden: decreased risk for men between 1992 and 2002

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Abstract Although mortality in older ages generally declined in most countries during the past decades less is known about mortality trends among the most vulnerable subset of the oldest old. The aim of this study was to investigate possible changes between 1992 and 2002 in the relation of complex health problems and mortality in two representative samples of the Swedish population aged 77+ (1992: $n = 537$; 2002: $n = 561$). Further, it was examined if trends differed by sex, education, and age. Serious problems in three health domains were identified (diseases/symptoms, mobility, cognition/communication). People with serious problems in two or three domains were considered to have complex health problems. Four-year mortality was analyzed using Cox proportional hazard regressions. Controlled for age, sex, education, and health status mortality risk decreased by 20% during the 10-year period. Complex health problems strongly predicted 4-year mortality in both 1992 and 2002. No single dimension explained the decrease. Men with complex health problems accounted for most of the decrease in mortality risk, so much that the gender difference in mortality risk was almost eliminated among elderly people with complex health problems 2002. A considerable decrease in the mortality risk among men with complex health problems has implications for the individual who may face longer periods of complex health problems and dependency. It will also place increasing demands upon medical and social services as well as informal caregivers.

Keywords Complex health problems · Multimorbidity · Mortality trends · Frail elderly people · Sweden

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Introduction

Trends in mortality in older ages have been characterized by an overall decline during the past decades in most low-mortality countries (Janssen et al. 2004; Kannisto et al. 1994). By contrast, health trends after the mid-1990s do not show a uniformly positive trend (Lafortune et al. 2007; Parker and Thorslund 2007). This raises the frequently discussed question whether the years added to life are characterized by good health and independence or by health problems and the need for care. The relationship between morbidity and mortality has essential implications for policy concerning medical care, social services, and long-term care. This study investigated the relation of 4-year mortality risk and complex health problems and how this relationship has changed between 1992 and 2002 in the Swedish population aged 77 years or older.

Health changes in the oldest sectors of the population reflect the interplay of morbidity and mortality patterns with demographic change (Myers et al. 2003). Studies using single health indicators have revealed widely divergent results. In general, trend studies seem to show improvement of disability measures (Freedman et al. 2002; Jacobzone 2000) at the same time that chronic disease, symptoms, and functional impairments have been increasing during the 1990s (Freedman and Martin 2000; Parker et al. 2005; Rosén and Haglund 2005; Waidmann and Liu 2000; Wen 2004). That is, an expansion of other

health problems may accompany a compression of disability (Parker and Thorslund 2007).

Studies covering multiple health domains often refer to frailty—a concept used to identify physiologically vulnerable older adults. Although there is no standard definition of frailty, operationalizations usually include the sum of a number of frailty markers, e.g., weakness, poor endurance, weight loss, low physical activity, and slow gait speed (Fried et al. 2001). Measures are commonly validated by their ability to predict negative outcomes, e.g., death, disability, or institutionalization (Fried et al. 2004; Mitnitski et al. 2005; Rockwood et al. 2004, 2006). Although there are several studies estimating the proportion of frail people in the population (Brayne et al. 2001; Fried et al. 2004), to the authors' knowledge, there are no studies looking at how proportions have changed over time. However, a few studies have investigated trends of multiple chronic conditions and disabilities. One study analyzed the prevalence of at least three unspecified longstanding diseases between 1980 and 2002 in the Swedish population aged 65–84 years. Predicted proportions for 70-year olds increased from 19 to 23% for men and from 25 to 30% for women. Prevalence rates of specific conditions included in the same study, heart disease, hypertension, and diabetes, also increased significantly between 1988 and 2000 (Rosén and Haglund 2005). A Swedish study based on the same data as this study used the concept of complex health problems defined as having serious problems in at least two of three domains: diseases/symptoms, mobility, cognition/communication (Meinow et al. 2006). Complex health problems in the population aged 77 years and older increased from 19 to 26% between 1992 and 2002. Compared to the definition of frailty as a state of purely physiologic vulnerability, the concept of complexity identifies individuals experiencing the cumulative effects of disease-related, functional, and cognitive limitations and being overtly functionally compromised (Whitson et al. 2007).

Many studies have analyzed the association between health problems—single items as well as measures of frailty—and mortality. One explanation for decreasing mortality rates at the same time as morbidity seems to be worsening among the oldest old is an increase of "sick survivors" (Rosén and Haglund 2005). Even elderly people who were once considered to have a very high mortality risk now seem to be surviving longer (Crimmins and Saito 2001). During the 1990s progress in treatment of cardiovascular disease contributed substantially to prolonged life expectancy (Boersma et al. 2003; Topol 2004). In particular, survival among even very old people with stroke and cardiac infarct has improved (Rosén and Haglund 2001, 2005), especially among men (Peltonen et al. 2000). However, many survivors continue to have chronic health problems.

Countries with a high proportion of elderly people and high life expectancy may be seen as forerunners in regard to population aging. Sweden has one of the world's oldest populations in regard to the proportion of people aged 80 or older, 5.5% in 2006. Life expectancy at birth 2006 was 82.9 years for women and 78.7 years for men. At the age of 80, average life expectancy was 7.6 years for men and 9.4 years for women (Statistics Sweden 2007). While measures of functional ability among Swedes aged 65 and older showed general improvement during the 1980s and the beginning of the 1990s, the development after 1995 has been less positive (Parker et al. 2006), possibly reflecting "the emergence of a very frail old population," as proposed by Robine and Michel (2004).

Mortality trends are usually monitored for the entire older population or for specific diseases. However, it remains unknown whether the decrease in mortality is a general trend in the older population or if there are specific subgroups that have experienced a more favorable development than others. Especially, little is known about trends in mortality risk among the most vulnerable subgroup of the oldest old. Has the association of complex health problems and mortality changed during the 1990s? And who has benefited most? For example, is the association of complex health problems and mortality different for men and women, for different age groups, and is it dependent on educational attainment? And have possible sex, age, and educational differences changed over time?

The aim of this study was to investigate change in the relation of mortality risk and complex health problems among persons aged 77 years and older between 1992 and 2002. Moreover, we ask if the association of complex health problems and mortality differed for subgroups of the older population in regard to gender, education, and age.

Methods

Sample

The Swedish Panel Study of the Living Conditions of the Oldest Old (SWEOLD) is a continuation of the Swedish Level-of-Living Survey (LNU), a panel interview concerning different aspects of the living conditions of the Swedish population aged 18–75. SWEOLD 1992 ($n = 537$) and 2002 ($n = 561$) consists of all persons who had been included in at least one LNU but who passed the upper age limit. The samples are representative of the population aged 77 years or older and comprise approximately 1‰ of the Swedish population in this age group (Lundberg and Thorslund 1996). Response rates were 95% in 1992 and 89% in 2002. In both studies professional interviewers conducted structured interviews with subjects.

Telephone interviews were conducted in some cases (6 and 7%), mainly due to unwillingness to receive an interviewer in the home. In cases where the respondent could not be interviewed, due to cognitive impairment or severe illness, a close relative or caregiver was interviewed (12 and 13%). Distribution of interview mode (direct, proxy, telephone) changed only marginally between the two surveys. The percentage of persons living in institutions (13 and 15%), age, and gender distributions reflect the national average for the 2 years. Prevalence rates over time may be sensitive to a number of methodological features, e.g., question wording, sample frame, the mode of interview, and non-response (Freedman et al. 2004). In this study, items were identical for 1992 and 2002.

Study variables

Complexity in health problems was measured by three health-related domains that are essential for the individual in maintaining independent living and relevant for planning of adequate medical care and social services: diseases/symptoms, mobility, and cognition/communication. As described in a previous study, people with serious problems in two or three of these domains were considered to have complex health problems (Meinow et al. 2006).

Variables were selected to represent a variety of health- and function-related problems. In order to make nationally representative estimates for the population aged 77 and older, measures were used that were available for all respondents, including proxy-interviewed (one exception is the cognition test, see below). Furthermore, because we were primarily interested in an individual's physical capacity we used measures that are less sensitive to environmental change (e.g., housing standard, assistive technology) and changes in gender roles, i.e., mobility items were used rather than Activities of Daily Living (ADL).

Diseases/symptoms

This domain was based on a list of common diseases and symptoms. The question was asked "Have you had any of the following diseases or symptoms during the last 12 months?" followed by a list of both diseases and symptoms. Individuals specified whether they had had no, mild, or severe problems with respect to general fatigue/sleeplessness, dizziness, leg ulcers, diabetes, stomach pain, myocardial infarction/other heart problems, stroke, breathlessness, chest pain, hypertension, joint pain, back pain, and shoulder pain. "No" was coded as 0, "Yes, mild problems" was coded as 1, and "Yes, severe problems" was coded as 3. Body Mass Index (BMI) was a single item, and a BMI under 16 was coded as severe underweight (3), between 16 and under 22 as mild underweight (1), and 22 or more as not underweight (0) (Andersen 2003). A summed index was constructed and a cutpoint for "serious health problems" was determined, comprising the highest quintile for 1992. Persons belonging to that category had, e.g., at least three severe diseases/symptoms or two severe and three mild. The same cutpoint was used for the 2002 sample, resulting in a prevalence rate of 31.7% (Meinow et al. 2006).

Mobility

Mobility was a domain consisting of four items. Respondents were asked if they could walk 100 m fairly briskly without difficulties, walk up stairs, rise from a chair without difficulty, and stand without support. Possible responses were "Yes" (0) and "No" (1). Persons having at least three limitations were considered to have serious mobility problems, comprising 20.6% of the 1992 sample and 26.9% in 2002 (Meinow et al. 2006).

Cognition/communication

Cognition was tested with items from the Folstein Mini-Mental State Examination (Folstein et al. 1975; Parker et al. 1996). Due to interview time constraints, items were selected for a total of 18 of the 30 original points. From the total possible score of 18, a previous study determined a cutoff using corresponding items in a larger Swedish study (HARMONY) that included the entire MMSE as well as clinical diagnoses of dementia. In HARMONY identically scored MMSE items were examined against clinical dementia diagnosis and the cutoff <12 best distinguished demented from non-demented (Gatz et al. 2005; Palmer et al. 2002). In our studies, we used this previously determined cutoff. Among the direct interviews, 13.1% scored below the cutoff and 2.2% did not do the test. For the indirect interviews, we studied interviewer notes and comments from relatives or care personnel concerning the reason for proxy interview. The vast majority of proxy-interviewed persons were too sick or weak to participate in an interview; common comments were "confused," "demented," and/or "suffering from aphasia." Therefore, respondents who scored below cutoff in the test or did not do the test or were not able to be interviewed directly were coded as having serious cognitive and/or communication problems, resulting in prevalence rates of 26.3% in 1992 and 32.4% in 2002.

Education was based on years of schooling. This was dichotomized into grade school or above.

Statistical methods

Date of death for all the deceased was collected from population registers and mortality was followed from the day of the interview until 20 July 1996 for the 1992 study and 12 April 2007 for the 2002 study, comprising an equally long follow-up time for both surveys of on average 1,625 days (about 4 years and 5 months). During this follow-up time 39.1% (211 individuals) of the 1992 study and 40.3% (226 individuals) of the 2002 study died.

Cox proportional hazard regressions were used to analyze mortality risk. In a first step, a general model was run including the number of domains with serious health problems, survey year, sex, age, and education. The risk of a variable was expressed as a hazard ratio (HR) with a corresponding 95% confidence interval (CI). Time under risk was measured in days from the interview until date of death or censoring.

In a second step we analyzed whether the association between complex health problems and mortality was different for the two survey years, for men and women, for different ages and levels of education. Thus, in order to analyze if the association of complex health problems and mortality had changed between 1992 and 2002, an interaction term of the number of health domains with serious problems and survey year was included, controlling for age, sex, and education. Correspondingly, interaction terms for the number of health domains with serious problems and sex, the number of health domains with serious problems and age, and the number of health domains with serious problems and education were also included, one at a time, in order to test whether the association of complex health problems and mortality differed by sex, age, or education.

In a third step, we tested whether sex, age, and educational differences in the association of health problems and mortality had changed between 1992 and 2002. We used three-way interactions between the number of domains with serious problems, survey year, and the other independent variables, one at a time.

Results

Descriptives

Table 1 describes the sample characteristics. Between 1992 and 2002 the proportion of individuals with complex health problems, i.e., serious problems in at least two of the three health domains, increased from 19 to 26% (24% when controlling for age). The proportion of persons with serious problems in one domain also increased significantly. Vice versa, the proportion of persons reporting no serious limitations decreased by one-fourth, from 56 to 42% (45% when controlling for age). Changes in prevalence rates of individuals having serious problems in 0, 1, or 2–3 health domains persisted when controlling for differences in the age composition in the two survey years. In both survey years complex health problems were more common among women than among men.

In both surveys, about 40% were men and 60% were women. During the 10-year period, the youngest age group, 77–79 years, decreased significantly from 26 to 20% whereas those 85 years or older increased from 31 to 38%. The percentage of individuals with education beyond grade school increased significantly from 23 to 31% between 1992 and 2002.

During the 4-year follow-up 211 individuals (39%) from the 1992 survey died, and 225 (40%) from the 2002 survey. The only significant change in mortality between the surveys occurred among men with complex health problems. In this group, the proportion of deceased during the 4-year follow-up decreased by one-third, from 94 to 64%. Among persons with education beyond grade school there was a tendency toward increased mortality.

Survival analyses

Table 2 presents hazard ratios for the whole sample. Compared to individuals with no serious problems in any domain those with serious problems in one domain had a 2.2 times higher mortality risk and those with complex health problems had a 4.1 times higher risk, showing that the included health domains had good predictive validity. Men had a 62% higher risk than women. Mortality risk increased with age, by approximately 10% for every year. Education showed no significant effect on mortality risk. Results were similar when using years of education as a continuous variable in the analyses (not shown). Controlled for age, sex, number of domains with serious health problems, and education, mortality risk decreased significantly by 20% during the 10-year period.

In order to analyze if the association of complex health problems and mortality differed by survey year, age, sex, and education, interactions between the number of domains with serious problems and the other independent variables (survey year, sex, age, education) were tested. Results showed no significant effects. However, there was a tendency of lower mortality risk for men with complex health problems compared to women (HR 0.67; $P = 0.109$) and a higher mortality risk for individuals with complex health problems having only basic education compared to those having more than basic education (HR 1.49; $P = 0.139$).

Table 1 Baseline SWEOLD sample characteristics 1992 and 2002

Characteristics	1992 ($n = 537$) % (n)	2002 ($n = 561$) % (n)	P value[a]	1992 % (n) Deceased during follow-up	2002 % (n) Deceased during follow-up	P value[a]
Number of domains with serious problems among						
Men[b]						
0	64.9 (137)	50.9 (115)	0.048	30.7 (42)	33.0 (38)	0.685
1	20.4 (43)	29.6 (67)	0.030	62.8 (27)	46.3 (31)	0.090
2–3	14.7 (31)	19.5 (44)	0.174	93.5 (29)	63.6 (28)	0.003
Women[c]						
0	49.8 (161)	36.6 (120)	0.001	18.6 (30)	15.8 (19)	0.541
1	28.2 (91)	32.6 (107)	0.359	45.1 (41)	40.2 (43)	0.490
2–3	22.0 (71)	30.8 (101)	0.029	59.2 (42)	65.3 (66)	0.408
All[d]						
0	55.8 (298)	42.4 (235)	<0.001	24.2 (72)	23.8 (57)	0.980
1	25.1 (134)	31.4 (174)	0.027	50.7 (68)	42.5 (74)	0.151
2–3	19.0 (102)	26.2 (145)	0.007	69.6 (71)	64.8 (94)	0.432
Sex						
Males	39.5 (212)	40.6 (228)	0.694	46.2 (98)	42.5 (97)	0.494
Females	60.5 (325)	59.4 (333)	0.694	34.8 (113)	38.7 (129)	0.291
All	100.0 (537)	100.0 (561)		39.1 (211)	40.3 (227)	0.692
Age group						
77–79	25.5 (137)	20.0 (112)	0.028	24.8 (34)	21.4 (24)	0.529
80–84	43.4 (233)	42.1 (236)	0.658	33.5 (78)	34.7 (82)	0.772
85+	31.1 (167)	38.0 (213)	0.017	59.3 (99)	56.3 (121)	0.628
Mean age ± SD	83.0 ± 4.21	83.7/83.0	0.003[f]			
Education[e]						
Only grade school (6-8 years)	76.9 (413)	68.4 (384)	0.002	41.6 (172)	40.4 (155)	0.713
Beyond grade school	22.5 (121)	30.7 (172)	0.002	30.6 (37)	41.3 (71)	0.062
Mean years ± SD	7.4 ± 2.47 (534)	8.0 ± 3.03 (556)	0.001[f]			

Proportion of deceased during 4-year follow-up

[a] P values for differences between 1992 and 2002, calculated with chi-square tests

[b] Due to missing mobility data, two cases in 1992 and five in 2002 were excluded

[c] Due to missing mobility data, one case in 1992 and two in 2002 were excluded

[d] Due to missing mobility data, three cases in 1992 and seven in 2002 were excluded

[e] Due to missing data on education, three cases in 1992 and five in 2002 were excluded

[f] P values for differences between 1992 and 2002, based on standard errors from bootstrap resampling with 1000 replications. In case of skewed variables the bootstrap method is an appropriate method for significance testing of differences between means. Based on a large number of random samples from the study-sample, differences between the mean values for 1992 and 2002 are performed for each of these samples. Based on the distribution of these differences, P values and standard errors are calculated

Three-way interactions between the number of domains with serious problems, survey year, and the other independent variables, one at a time, were used to test if sex *differences*, age *differences*, and educational *differences* in the association of health problems and mortality had changed between 1992 and 2002. Results revealed that sex differences in the association of the number of domains with serious problems and mortality changed significantly between 1992 and 2002 ($P = 0.001$) (not shown).

On the basis of these results and in order to make results from three-way interactions more readable, a categorical variable was constructed combining survey year, sex, and number of domains with serious problems, thus having 12 categories. This variable was entered into Cox regression models controlling for age and education. Table 3 shows hazard ratios (HR) for the 12 categories. Women in 1992 without serious problems in any health domain were the reference group.

Table 2 Number of domains with serious problems and mortality 1992–1996 and 2002–2006, hazard ratios from multivariate Cox regression

	Hazard ratio	*P* value	95% Confidence interval
Number of domains with serious problems			
0	1.00		
1	2.17	<0.001	1.70–2.77
2–3	4.06	<0.001	3.17–5.20
Sex			
Women	1.00		
Men	1.62	<0.001	1.34–1.97
Higher age	1.10	<0.001	1.08–1.12
Education			
Beyond grade school (>6–8 years)	1.00		
Only grade school (6–8 years)	0.99	0.955	0.80–1.24
Year of interview			
1992	1.00		
2002	0.80	0.021	0.66–0.97

Table 3 Mortality risk for men and women by year of interview and number of domains with serious problems

Number of domains with serious problems	1992[a]	2002[a]	2002/1992[b]
Women			
0	1.00	0.80	0.80 (0.447)
1	2.61 (<0.001)	2.05 (0.001)	0.79 (0.275)
2–3	4.23 (<0.001)	4.40 (<0.001)	1.04 (0.846)
Men			
0	1.94	1.85	0.95 (0.826)
1	3.59 (0.015)	3.37 (0.014)	0.94 (0.816)
2–3	12.45 (<0.001)	3.82 (0.004)	0.31 (<0.001)

Hazard ratios from Cox regressions, controlled for age and education. *P* values in parenthesis

[a] Significance tests for differences in mortality risks compared to persons having no serious problems in any domain for each sex and survey year

[b] Quotient of hazard ratios for 2002 compared to 1992. Significance tests for mortality risk differences between 1992 and 2002

Among individuals with serious problems in no or one domain, women had lower 4-year mortality risk than men both in the 1992 survey and the 2002 survey. These groups showed no significant change in mortality risk over time.

By contrast, among persons with serious problems in at least two domains, sex differences in mortality risk changed significantly between the two survey years. Men with complex health problems showed a considerable decrease in mortality risk whereas women's mortality risk did not change significantly. Thus, the decrease of mortality risk among men with complex health problems accounted for the decrease in mortality risk between 1992 and 2002 when looking at the whole sample as done in Table 2. When testing each of the three health domains separately, a similar pattern of decreased mortality risks among men was found (not shown). Accordingly, no single health domain accounted for the decrease in mortality risk among men with complex health problems.

Discussion

In this study changes in the relation of complex health problems and 4-year mortality risk were analyzed in two representative samples of the Swedish oldest old 1992 and 2002. In addition the question was addressed if trends in the association of complex health problems and mortality differed by sex, education, and age.

The presence of complex health problems, measured as having serious problems in at least two of three health domains, was a strong predictor of 4-year mortality in both 1992 and 2002, independent of age, sex, and education. When looking at the whole sample, mortality decreased by 20% between 1992 and 2002, independent of all other variables.

A closer look at subgroups of the oldest old indicated that sex differences in the association of complex health problems and mortality changed over the 10-year period. In general, women had lower mortality risks than men at all levels of health status. However, the significant decrease in mortality risk among men with complex health problems between 1992 and 2002 eliminated the sex difference in this most vulnerable group. Men with complex health problems accounted for the general decrease in mortality risk between 1992 and 2002. A similar decrease in

mortality risk for men was found when looking at each of the three domains separately. Thus, no single domain accounted for the decreased mortality among men with complex health problems.

Trends in old-age mortality reflect the complex interplay of cohort factors, period factors, and a combination of both. Cohort factors include, e.g., sociodemographic change. Period factors comprise, e.g., medical care developments and access to medical care. Changes in health behavior, for example, may imply a combination of both period and cohort effects.

To the authors' knowledge there are no similar studies comparing mortality risks for the most vulnerable subgroups of the oldest old over time. However, some trends in mortality and morbidity support our findings of decreasing sex differences in mortality risk among the most vulnerable oldest old.

In the general population, demographic trends have shown a narrowing of the gender gap in several OECD countries since the mid-1980s, and this trend is expected to continue in the future (OECD 2007). Between 1992 and 2002, the survey years of this study, the average life expectancy at 65 years in Sweden increased with 0.7 years for women and 1.4 years for men (Statistics Sweden 2007). Thus, decreased mortality for subgroups of the elderly population, e.g., the frailest men, could contribute to the trend of converging mortality risks for men and women seen in the general population.

Cardiovascular diseases continue to be the dominating causes of death above the age of 75 in Sweden (NBHW 2009). However, mortality from these diseases has decreased considerably in Sweden and other countries (Boersma et al. 2003; Rosén 2006; Topol 2004), and this is the main factor for an increase in life expectancy in recent years (NBHW 2009). Since cardiovascular diseases are more common among men, the potential gains from healthcare interventions and progress in treatment are larger for men than for women (Persson et al. 2006; Rosén and Haglund 2005). As the symptom/diseases domain in our study comprises several indicators of cardiovascular problems, this could contribute, to some extent, to our results of a decrease of mortality risk between 1992 and 2002 among men with complex health problems but not among women. However, since cardiovascular diseases comprise rather specific health measures, their weaker relation to mortality constitutes no single explanation of our results.

In our study mortality risk among men and women without any serious problems or with serious problems in only one domain did not change significantly between the two survey waves. Accordingly, persons with extensive health problems may have benefited more from advances in medical care than relatively healthy individuals. This is in line with the hypothesis that increased longevity in Sweden in the 1990s was mainly due to successful life-saving interventions from medical care whereas it was healthier lifestyles that contributed substantially to prolonged life expectancy in the 1980s (Rosén and Haglund 2005).

Decreased mortality risk among men with complex health problems but not among women could also emerge due to gender inequities in access to healthcare. A recent Swedish study on the general adult population reported that women have to wait longer for treatment and receive less advanced physical examinations (Swedish Association of Local Authorities and Regions 2007). Women are less often prescribed newer and more expensive drugs than men (NBHW 2004; Swedish Association of Local Authorities and Regions 2007) and are more often exposed to inappropriate drug use (Johnell et al. 2009). Sweden is not alone in providing preferential treatment. Research from England and Wales found that coronary revascularization is less often provided for women and older people (Shaw et al. 2004).

Another contributing factor could be convergence in risk-factor behaviors (e.g., smoking) among men and women (OECD 2007). However, increased prevalence of smoking among younger generations of women has so far only led to a moderate increase of smoking prevalence among the oldest old. The inclusion of information about actual or previous smoking habits in this study did not affect results (not shown).

As discussed above, trends in the association of complex health problems and mortality apparently differed for men and women. However, age and education did not seem to affect the association between complex health problems and mortality. However, this study only included persons 77 years and over; younger age groups may show different patterns. For example, a study in men aged 65 and above found that the association between frailty and mortality was stronger in younger than in men older than 80 (Cawthon et al. 2007). However, these results referred to a clinical study based on a community dwelling sample with additional eligibility criteria and may, therefore, differ from population-based results.

Several studies demonstrated that socioeconomic inequalities in mortality persist even among older people (Bassuk et al. 2002; Huisman et al. 2004). By contrast, in this study education was not significantly related to mortality when taking health problems into account. However, complex health problems were more common among individuals with only basic education (Meinow et al. 2006) thereby creating higher vulnerability among low educated people. Similar to an American study (Clark et al. 2007), there was no evidence of educational differences in morality risk among people with complex health problems.

The sample and measures in this study are specific in several respects. Compared to many clinical studies of multimorbidity in this study the classification of the most vulnerable subgroup of the oldest old is rather crude and not intended to be used as a clinical screening instrument for initiating medical treatment. Rather, measures were selected to reflect serious problems in three domains important for the individual in maintaining independence and well-being, as well as for social policy concerning medical and long-term care, and support to informal caregivers.

Apart from the cognition test, the health indicators used in this study are self-reported. When analyzing self-reported items, there is always uncertainty about the extent to which changes over time can be attributed to changes in reporting and environmental modifications. For example, an increase of the prevalence of health problems may be due to higher awareness and more frequent diagnosing in later cohorts. More frequent use of assistive devices, housing adaptations, and better accessibility, on the other hand, may lead to decreased reporting of disability. However, a study carried out with the same SWEOLD data confirmed the significant worsening of health between 1992 and 2002 when examining objective tests of function (peak flow, physical performance). Tests are less sensitive to reporting differences, rising expectations, and environmental modifications (Parker et al. 2005). Furthermore, we analyzed self-reported measures of mobility as these are probably less sensitive to environmental modifications compared to ADL.

Studies on the association of mortality and health problems in multiple domains—often based on frailty or multimorbidity—are often clinically based, or based on specific eligibility criteria and do not reveal results for the whole older population (Cawthon et al. 2007; Purser et al. 2006). Compared to many surveys from larger countries, the SWEOLD samples are small. However, they are representative of the Swedish population aged 77 years and older since non-response was low in both surveys, and institutionalized, cognitively impaired persons and proxy data were included. This is of particular importance since individuals with complex health problems probably are overrepresented among older adults living in institutions and among persons interviewed by proxy. Even if the institutionalized population in countries is small, its inclusion is important as thresholds for access to institutions change over time, thereby influencing prevalence rates of health problems among those living in the community.

This study did not include information about incidence of health problems. However, even if dates of diagnoses were available, health problems may have existed some time before and may develop gradually. This applies for both the 1992 and the 2002 survey and probably did not affect comparisons of mortality risks between the two survey waves. SWEOLD design and fieldwork were similar in both survey years, and only identical items were used in this study.

Conclusion

Using a multidimensional measure of complex health problems in two representative samples of the Swedish population aged 77 years and older, including institutionalized persons and proxy data, revealed a substantial decrease of mortality risk among men with complex health problems during the 10-year period. Prevalence rates of multiple health problems have increased during the past two decades (Meinow et al. 2006; Rosén and Haglund 2005). Many who today survive medical events will later in life contract other diseases and functional impairments, e.g., depression or cancer (Ladwig et al. 1994; Persson et al. 2006; Rosén and Haglund 2005; Waidmann and Liu 2000). This has implications for the individual and their families who may face longer periods of complex health problems and dependency. It will also place increasing demands upon medical and social services. Old-age mortality has been shown to be highly plastic and susceptible to many factors, e.g., change in behavioral risk factors like smoking, changes in alcohol consumption, improvements in the living conditions and health care (Janssen et al. 2004). Therefore, it is important to investigate change in the relation of multiple health problems and mortality for different subgroups of the older population in other countries and for longer time periods.

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References

Andersen M (ed) (2003) Mat och näring för sjuka inom vård och omsorg [Diet and nutrition for persons receiving social services or medical care]. Livsmedelsversket, Uppsala

Bassuk SS, Berkman LF, Amick BC 3rd (2002) Socioeconomic status and mortality among the elderly: findings from four US communities. Am J Epidemiol 155(6):520–533

Boersma E, Mercado N, Poldermans D, Gardien M, Vos J, Simoons ML (2003) Acute myocardial infarction. Lancet 361(9360):847–858

Brayne C, Matthews FE, McGee MA, Jagger C (2001) Health and ill-health in the older population in England and Wales. The Medical Research Council Cognitive Function and Ageing Study (MRC CFAS). Age Ageing 30(1):53–62

Cawthon PM, Marshall LM, Michael Y, Dam TT, Ensrud KE, Barrett-Connor E, Orwoll ES (2007) Frailty in older men:

prevalence, progression, and relationship with mortality. J Am Geriatr Soc 55(8):1216–1223
Clark DO, Stump TE, Miller DK, Long JS (2007) Educational disparities in the prevalence and consequence of physical vulnerability. J Gerontol B Psychol Sci Soc Sci 62(3):S193–S197
Crimmins EM, Saito Y (2001) Trends in healthy life expectancy in the United States, 1970–1990: gender, racial, and educational differences. Soc Sci Med 52(11):1629–1641
Folstein MF, Folstein SE, McHugh PR (1975) "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 12(3):189–198
Freedman VA, Martin LG (2000) Contribution of chronic conditions to aggregate changes in old-age functioning. Am J Public Health 90(11):1755–1760
Freedman VA, Martin LG, Schoeni RF (2002) Recent trends in disability and functioning among older adults in the United States: a systematic review. JAMA 288(24):3137–3146
Freedman VA, Crimmins E, Schoeni RF, Spillman BC, Aykan H, Kramarow E, Land K, Lubitz J, Manton K, Martin LG, Shinberg D, Waidmann T (2004) Resolving inconsistencies in trends in old-age disability: report from a technical working group. Demography 41(3):417–441
Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, Seeman T, Tracy R, Kop WJ, Burke G, McBurnie MA (2001) Frailty in older adults: evidence for a phenotype. J Gerontol A Biol Sci Med Sci 56(3):M146–M156
Fried LP, Ferrucci L, Darer J, Williamson JD, Anderson G (2004) Untangling the concepts of disability, frailty, and comorbidity: implications for improved targeting and care. J Gerontol A Biol Sci Med Sci 59(3):255–263
Gatz M, Fratiglioni L, Johansson B, Berg S, Mortimer JA, Reynolds CA, Fiske A, Pedersen NL (2005) Complete ascertainment of dementia in the Swedish Twin Registry: the HARMONY study. Neurobiol Aging 26(4):439–447
Huisman M, Kunst AE, Andersen O, Bopp M, Borgan JK, Borrell C, Costa G, Deboosere P, Desplanques G, Donkin A, Gadeyne S, Minder C, Regidor E, Spadea T, Valkonen T, Mackenbach JP (2004) Socioeconomic inequalities in mortality among elderly people in 11 European populations. J Epidemiol Community Health 58(6):468–475
Jacobzone S (2000) Coping with aging: international challenges. Health Aff 19(3):213–225
Janssen F, Mackenbach JP, Kunst AE (2004) Trends in old-age mortality in seven European countries, 1950–1999. J Clin Epidemiol 57(2):203–216
Johnell K, Weitoft GR, Fastbom J (2009) Sex differences in inappropriate drug use: a register-based study of over 600,000 older people. Ann Pharmacother 43(7):1233–1238
Kannisto V, Lauritsen J, Thatcher AR, Vaupel JW (1994) Reductions in mortality at advanced ages: several decades of evidence from 27 countries. Popul Dev Rev 20(4):793–810
Ladwig KH, Roll G, Breithardt G, Budde T, Borggrefe M (1994) Post-infarction depression and incomplete recovery 6 months after acute myocardial infarction. Lancet 343(8888):20–23
Lafortune G, Balestat G, Disability Study Expert Group Members (2007) Trends in severe disability among elderly people: assessing the evidence in 12 OECD countries and the future implications. Health working papers no. 26. OECD, Paris
Lundberg O, Thorslund M (1996) Fieldwork and measurement considerations in surveys of the oldest old. Soc Indic Res 37:165–187
Meinow B, Parker MG, Kåreholt I, Thorslund M (2006) Complex health problems in the oldest old in Sweden 1992–2002. Eur J Ageing 3(2):98–106
Mitnitski A, Song X, Skoog I, Broe GA, Cox JL, Grunfeld E, Rockwood K (2005) Relative fitness and frailty of elderly men and women in developed countries and their relationship with mortality. J Am Geriatr Soc 53(12):2184–2189
Myers GC, Lamb VL, Agree EM (2003) Patterns of disability change associated with the epidemiologic transition. In: Robine JM, Jagger CD, Mathers CD, Crimmins EM, Suzman RM (eds) Determining health expectancies. Wiley, Chichester, pp 59–74
NBHW (2004) Jämställd vård? Könsperspektiv på hälso- och sjukvården [Equality in health care? Gender perspective on the health care system]. National Board of Health and Welfare, Stockholm
NBHW (2009) Folkhälsorapport 2009 [National Health Report 2009]. National Board of Health and Welfare, Stockholm
OECD (2007) Society at a glance 2006. http://caliban.sourceoecd.org/vl=1221472/cl=12/nw=1/rpsv/society_glance/24.htm. Retrieved February 2008
Palmer K, Wang HX, Backman L, Winblad B, Fratiglioni L (2002) Differential evolution of cognitive impairment in nondemented older persons: results from the Kungsholmen Project. Am J Psychiatry 159(3):436–442
Parker MG, Thorslund M (2007) Health trends in the elderly population: getting better and getting worse. Gerontologist 47(2):150–158
Parker MG, Gatz M, Thorslund M (1996) Brief cognitive screening in a field survey of the oldest old. Aging 8(5):354–359
Parker MG, Ahacic K, Thorslund M (2005) Health changes among Swedish oldest old: prevalence rates from 1992 and 2002 show increasing health problems. J Gerontol A Biol Sci Med Sci 60(10):1351–1355
Parker MG, Schön P, Thorslund M (2006) Utvecklingen av de äldres funktionsförmåga [Functional ability in the elderly Swedish population]. In: Statistics Sweden (ed) Äldres levnadsförhållanden: arbete, ekonomi, hälsa och sociala nätverk 1980–2003 [Living conditions of elderly people: work, economy, health and social networks 1980–2003]. Statistics Sweden, Stockholm, pp 329–354
Peltonen M, Lundberg V, Huhtasaari F, Asplund K (2000) Marked improvement in survival after acute myocardial infarction in middle-aged men but not in women. The Northern Sweden MONICA study 1985–94. J Intern Med 247(5):579–587
Persson G, Danielsson M, Rosen M, Alexanderson K, Lundberg O, Lundgren B, Stenbeck M, Wall S (2006) Health in Sweden: The National Public Health Report 2005. Scand J Public Health 34(Suppl 67):3–10
Purser JL, Kuchibhatla MN, Fillenbaum GG, Harding T, Peterson ED, Alexander KP (2006) Identifying frailty in hospitalized older adults with significant coronary artery disease. J Am Geriatr Soc 54(11):1674–1681
Robine JM, Michel JP (2004) Looking forward to a general theory on population aging. J Gerontol A Biol Sci Med Sci 59(6):M590–M597
Rockwood K, Howlett SE, MacKnight C, Beattie BL, Bergman H, Hebert R, Hogan DB, Wolfson C, McDowell I (2004) Prevalence, attributes, and outcomes of fitness and frailty in community-dwelling older adults: report from the Canadian Study of Health and Aging. J Gerontol A Biol Sci Med Sci 59(12):1310–1317
Rockwood K, Mitnitski A, Song X, Steen B, Skoog I (2006) Long-term risks of death and institutionalization of elderly people in relation to deficit accumulation at age 70. J Am Geriatr Soc 54(6):975–979
Rosén M (2006) Chapter 5.1: major public health problems—cardiovascular diseases. Scand J Public Health 34(Suppl 67):51–58
Rosén M, Haglund B (2001) The importance of health and medical care for public health. Health in Sweden: The National Public Health Report 2001. Scand J Public Health 29(Suppl 58): 219–230

Rosén M, Haglund B (2005) From healthy survivors to sick survivors—implications for the twenty-first century. Scand J Public Health 33(2):151–155

Shaw M, Maxwell R, Rees K, Ho D, Oliver S, Ben-Shlomo Y, Ebrahim S (2004) Gender and age inequity in the provision of coronary revascularisation in England in the 1990s: is it getting better? Soc Sci Med 59(12):2499–2507

Statistics Sweden (2007) Population statistics. http://www.scb.se/templates/Amnesomrade_1954.asp. Retrieved December 2007

Swedish Association of Local Authorities and Regions (2007) (O)jämställdhet i hälsa och vård - En genusmedicinsk kunskapsöversikt [Inequity in health and health care]. Swedish Association of Local Authorities and Regions, Stockholm

Topol EJ (2004) Intensive statin therapy—a sea change in cardiovascular prevention. N Engl J Med 350(15):1562–1564

Waidmann TA, Liu K (2000) Disability trends among elderly persons and implications for the future. J Gerontol B Psychol Sci Soc Sci 55(5):S298–S307

Wen X (2004) Trends in the prevalence of disability and chronic conditions among the older population: implications for survey design and measurement of disability. Australas J Ageing 23(1):3–6

Whitson HE, Purser JL, Cohen HJ (2007) Frailty thy name is… Phrailty? J Gerontol A Biol Sci Med Sci 62(7):728–730