Comorbid chronic diseases, discordant impact on mortality in older people: a 14-year longitudinal population study

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ABSTRACT

Objectives To determine the impact of comorbid chronic diseases on mortality in older people.

Design Prospective cohort study (1992–2006). Associations between numbers of chronic diseases or mutually exclusive comorbid chronic diseases on mortality over 14 years, by Cox proportional hazards model adjusting for sociodemographic variables or Kaplan–Meier analyses, respectively.

Setting Population based, Australia.

Participants 2087 randomly selected participants aged ≥65 years old, living in the community or institutions.

Main results Participants with 3–4 or ≥5 diseases had a 25% (95% CI 1.05 to 1.5, p=0.01) and 80% (95% CI 1.5 to 2.2, p<0.0001) increased risk of mortality, respectively, by comparison with no chronic disease, after adjusting for age, sex and residential status. When cardiovascular disease (CVD), mental health problem or diabetes were comorbid with arthritis, there was a trend towards increased survival (range 8.2–9.5 years) by comparison with CVD, mental health problem or diabetes alone (survival 5.8–6.9 years). This increase in survival with arthritis as a comorbidity was negated when CVD and mental health problems or CVD and diabetes were present in disease combinations together.

Conclusion Older people with ≥3 chronic diseases have increased risk of mortality, but discordant effects on survival depend on specific disease combinations. These results raise the hypothesis that patients who have an increased likelihood of opportunity for care from their physician are more likely to have comorbid diseases detected and managed.

INTRODUCTION

The prevalence of multiple chronic diseases (multimorbidity) is 65–80% in older people and is projected to rise with the increasing older population.[1 2] Despite this, the majority of clinical practice and research to date has a single-disease-based paradigm, which may not be suitable for older patients with multiple morbidities.[3–5] While evidence-based guidelines can assist practitioners to make appropriate treatment choices, relatively few of these guidelines take into account patients with multiple chronic conditions. As such, their applicability to the population of older people has been questioned.[3 4 6 7]

It is becoming increasingly evident that primary care must become more centred on the whole patient rather than on individual diseases.[3 5] Knowledge of the most prevalent morbidity combinations in older people will help to facilitate the development of appropriate guidelines for management and coordination of care for these patients. Additionally, an understanding of the impact of these combinations of chronic diseases on mortality may further help to highlight the importance of appropriate, timely and comprehensive treatment strategies for patients with particular chronic disease profiles.

Much of the research on multimorbidity has focused on the prevalence of coexistent chronic diseases,[2 8–10] or the overall impact of multimorbidity on health. Multimorbidity is associated with a decrease in quality of life, self-rated health and functional status.[11 12] It is also associated with increased mortality, with two or more chronic diseases resulting in a twofold or more increase in mortality risk.[11 13 14] However, the effects of specific combinations of chronic diseases on health outcomes, costs and quality of care is less well studied, and as such there is a strong need for more clinically relevant research if we are to provide optimal care for patients with multiple chronic diseases.[15] A US study reported significant differences in the age-adjusted 5-year mortality rate for veterans with hypertension, depression and osteoarthritis of 4.2% compared to 34.6% for those with hypertension, cancer and chronic obstructive pulmonary disorder.[14]

The aim of this study is to determine the impact of specific chronic disease combinations and the effects of multimorbidity on mortality over a 14-year period in older people (≥65 years old). This study will focus on those chronic diseases that account for the majority of mortality and burden of disease worldwide.[16]

METHODS

Study sample

The study sample included 2087 men and women, aged 65 years and older, from the Australian Longitudinal Study of Ageing, which has previously been described.[17] Briefly, it is a large prospective population-based study of human ageing. It began in 1992 with the primary sample randomly selected from the South Australian Electoral Roll, with subjects stratified by gender, location and cohorts aged 65–69, 70–74, 75–79, 80–84 and 85 years or older. Older men were oversampled to ensure sufficient numbers for longitudinal follow-up. Written informed consent was obtained from all participants, and the study

protocol was approved by the Flinders University. The University of South Australia additionally approved the design upon which this report is based.

Measurements

Chronic diseases

The prevalence of chronic diseases was assessed in face-to-face interviews by asking participants with the aid of prompt cards whether they had ever suffered from, or currently have, any of the following chronic conditions: arthritis, osteoporosis, cancer (including bladder, bowel, breast, colon, gynaecological, leukaemia, lung, melanoma, prostate, rectal or other cancer), diabetes, asthma, chronic bronchitis, angina, heart attack, heart condition, stroke, small stroke (transient ischaemic attack), hypertension, mental disorder, nervous breakdown, hiatus hernia and gastrointestinal ulcer. The presence of depressive symptoms was measured using the Centre for Epidemiological Studies-Depression Scale,[18] with a clinically relevant level of depression defined by a score of ≥16.

Individual chronic diseases were grouped where appropriate into broader disease categories, including cardiovascular disease (CVD) (angina, heart attack, heart condition, stroke, small stroke), mental health problem (mental disorder, nervous breakdown, depression), gastrointestinal disease (hiatus hernia, gastrointestinal ulcer) and respiratory disorder (asthma, chronic bronchitis).

Self-rated health and activities of daily living

The association between self-rated health or activities of daily living at baseline and specific comorbid diseases was assessed. Self-rated health provides a global assessment of the participant's perception of overall health status. Participants were asked, "In general how would you rate your present health?" with five response categories (poor, fair, good, very good or excellent).[19] For the analyses of specific disease combinations, the responses were grouped into two categories: (poor or fair) (good, very good or excellent).

Physical impairment was assessed using the activities of daily living that included eight self-care activities: bathing, personal grooming, dressing, eating, using the toilet, going to a place away from home, moving inside the house and transferring from bed to chair. In this study, the responses were dichotomised into no difficulty with any activity and difficulty with one or more activities.

Mortality

The primary endpoint for this part of the study was all-cause mortality. Survival data were obtained from death certificates searched by the Epidemiology Branch of the Department of Health in South Australia, and deaths were confirmed by the South Australian Births, Deaths and Marriages Registration Office, as described and validated previously.[20 21] If no direct match was made, the electoral roll was checked for name or address changes or errors and for those whose deaths occurred in another state or overseas. The date of death was supplied by informants nominated by participants at baseline. For each participant, time to event was calculated as the interval between baseline interview date and the date of death or the date of administrative censoring on 31 December 2006, whichever occurred first.

Statistical analyses

Baseline demographic and health characteristics were stratified by number of chronic diseases. Comparisons were made between those with 0, 1, 2, 3–4 and ≥5 chronic diseases using Pearson χ^2 test for categorical variables and one-way ANOVA for continuous variables. The association between the numbers of chronic diseases and mortality was examined using Cox proportional hazards models adjusting for age, sex and residential status. Kaplan–Meier analyses were used to examine mutually exclusive specific chronic diseases or combinations of chronic diseases on mortality. Only those chronic disease combinations with a prevalence of 0.5% or higher were included in this analyses. All analyses were performed using SAS version 9.1 (SAS Institute, Inc).

RESULTS

Table 1 displays the baseline demographic and health characteristics of participants, classified according to the number of chronic diseases. Almost 90% of respondents reported having at least one chronic disease, with 64% reporting two or more chronic diseases (table 1). The age of respondents was similar between the groups with differing numbers of chronic diseases, with the average age ranging from 77.9 to 78.6 years old. Gender, education level, income and marital status of participants were also similar between the groups (table 1). Compared with persons who had no chronic diseases, those with increasing numbers of diseases were less likely to live within the community, have poorer self-rated health and have difficulties with more than one activity of daily living.

The overall prevalence of chronic diseases and disease groupings is reported in table 2. Fifty-four per cent of respondents reported arthritis, with only 13% reporting arthritis as their only condition. Similarly, while 36% reported having CVD, only 9% reported CVD as their only condition (table 2). Table 2 also shows the prevalence of specific chronic disease combinations. Arthritis and CVD was the most common disease combination, followed by arthritis together with hypertension or gastrointestinal disease or mental health problem. Almost 10% of the study sample reported the presence of arthritis, CVD and hypertension, and 3.6% reported this combination together with gastrointestinal disease. Arthritis was the most common comorbid disease, followed by CVD, gastrointestinal disease, hypertension and mental health problem.

When considering single conditions, CVD or mental health problem tended to have poorer self-rated health, by comparison to those with no disease or other single diseases (table 3). An increase in the prevalence of those reporting poor or fair self-rated health was generally observed with the addition of comorbidity to each of the index diseases. This was most apparent in those with CVD or mental health problem (table 3). For most index diseases, there was a trend to increased difficulty with activities of daily living with the addition of comorbidity (table 3). In general, when arthritis was present as a comorbidity, there was a reduced ability to perform activities of daily living. This was most evident in those with mental health problem (table 3).

A total of 1469 subjects died during the 14-year follow-up period, representing 70.4% of the study population. Survival analysis (adjusted for age, gender and residential aged care status) demonstrated that with increasing numbers of chronic diseases at baseline, there was a statistically significant decrease in survival (figure 1). The median survival time for older people who had no chronic diseases at baseline was 10.4 years (95% CI 9.2 to 11.6) (figure 1). By comparison, the median survival times of those with 1, 2, 3–4 and ≥5 chronic diseases was 10.1 years (95% CI 9.2 to 11.0), 9.6 years (95% CI 8.7 to 10.5),

Table 1 Baseline demographics, self-rated health and activities of daily living categorised by number of chronic diseases (n=2087)

	0 Chronic disease (n=266)	1 Chronic disease (n=486)	2 Chronic diseases (n=498)	3–4 Chronic diseases (n=575)	≥5 Chronic diseases (n=262)	p Value
Overall prevalence % (95% CI)	12.7 (11.3 to 14.3)	23.3 (21.4 to 25.2)	23.9 (22.1 to 25.7)	27.6 (25.6 to 29.5)	12.6 (11.2 to 14.1)	
Sex (% female)	51.9	47.9	48.4	48.7	53.1	0.59
Age, mean (SD)	78.6 (7.3)	78.3 (6.9)	77.9 (6.5)	78.1 (6.4)	78.6 (6.4)	0.015
Age groups (years, %)						0.009
65–69	9.4	6.8	6.0	6.0	5.3	
70–74	24.8	26.5	28.7	25.9	27.4	
75–79	18.1	24.6	27.4	27.9	22.1	
80–84	26.7	19.1	18.0	20.8	23.9	
85+	20.9	23.1	19.9	19.5	21.2	
Place of residence (%)						<0.0001
Community	94.0	95.5	95.4	94.4	87.4	
Institution	6.0	4.5	4.6	5.6	12.6	
Education (age left school, %)						0.63
<14 years	19.1	14.8	15.6	16.8	16.7	
≥14 years	80.9	85.2	84.4	83.2	83.3	
Income						0.65
≤US$12000	36.3	35.1	35.8	34.2	38.2	
US$12001–20000	43.8	43.6	43.8	47.2	44.3	
US$20001–30000	12.5	10.3	11.5	11.3	11.8	
>US$30000	7.5	11.0	8.9	7.3	5.7	
Marital status						0.09
Never married	3.0	2.3	5.4	3.7	3.4	
Married/de facto	65.1	66.7	62.7	67.6	64.9	
Widowed	28.6	28.2	28.7	26.1	31.7	
Divorced/separated	3.4	2.9	2.2	2.6	0	
Self-rated health						<0.0001
Excellent	19.3	15.5	7.8	3.8	1.5	
Very good	43.4	37.4	30.7	22.3	8.4	
Good	29.8	28.3	33.3	34.9	19.5	
Fair	6.4	15.1	21.7	29.1	42.9	
Poor	1.1	3.7	6.4	9.8	27.6	
Activities of daily living						<0.0001
No difficulties	90.6	90.0	84.9	76.3	65.3	
More than 1	9.4	10.0	15.6	20.7	34.7	

p Values were derived from Pearsons χ^2 test for association between the indicated variable and the number of chronic diseases for categorical variables or one-way ANOVA for continuous variables.

8.9 years (95% CI 7.9 to 9.9) and 6.4 years (95% CI 5.7 to 7.0), respectively.

When considering those with only one disease, the presence of CVD or mental health problem or diabetes was associated with a minimum 33% reduction in survival by comparison to those with no chronic disease or arthritis or gastrointestinal disease or hypertension (table 4). Interestingly, the addition of arthritis as a comorbidity with either CVD or mental health problem or diabetes resulted in a trend towards an increase in survival (table 4). For example, the median survival time of those with a mental health problem only was 6.0 years (95% CI 3.9 to 11.9); however, when arthritis was present, median survival time increased to 9.5 years (95% CI 6.0 to 11.8) (table 4). However, this increase in survival associated with arthritis was negated when CVD and mental health problem were comorbid, or when diabetes and CVD were comorbid in two, three or four disease combinations (where applicable) (table 4). Thus, the simple addition of another comorbid disease to specific diseases or disease combinations did not necessarily result in an additive or multiplicative effect on mortality.

DISCUSSION

In the present study, we found a high prevalence of multimorbidity, with almost two-thirds of the population of older people reporting two or more chronic diseases. The presence of three or more chronic diseases was associated with a 25% increased risk of mortality over the 14-year study period, while five or more chronic diseases was associated with an 80% increased risk of mortality. Importantly, this study described discordant effects of specific comorbid disease combinations on mortality in older people. CVD and mental health problems were highly prevalent comorbidities and were associated with increased mortality. In contrast, diabetes, which was one of the least common comorbid diseases, tended to have the greatest effect on mortality when comorbid with CVD. Arthritis, however, was the most prevalent comorbid disease but was generally associated with longer survival times. This increased survival associated with arthritis was negated when CVD and mental health problem or CVD and diabetes were present in diseases combinations together.

Despite the reported high prevalence of multimorbidity in older people and the major impact of chronic diseases with regard to their huge disease burden and associated costs, there are comparatively few studies that have focused on the long-term mortality (more than 5 years of follow-up) associated with multiple chronic diseases. Our data agree with previous studies of shorter duration that report that multimorbidity has a negative impact on mortality.[11 13 22] In light of our findings regarding the differing impacts of specific disease combinations on mortality, an understanding that diabetes alone is associated

Table 2 Prevalence of chronic diseases or disease groupings and multimorbidity at baseline (n=2087)

Arthritis	Cancer	CVD*	Diabetes	GI Disease*	HT	MHP*	Respiratory Disease*	Prevalence, % (95% CI)
X								54.2 (52.0-56.3)
		X						36.0 (34.0-38.1)
					X			31.9 (29.9-34.0)
						X		28.4 (26.4-30.3)
				X				26.1 (24.2-28.1)
							X	17.3 (15.7-19.0)
	X							13.8 (12.3-15.3)
			X					8.7 (7.5-10.0)
X		X						21.2 (19.4-23.0)
X					X			19.1 (17.5-20.9)
X				X				18.2 (16.5-19.9)
X						X		16.9 (15.3-18.5)
		X			X			15.0 (13.5-16.6)
		X				X		12.0 (10.7-13.5)
		X		X				11.2 (9.9-12.6)
X							X	10.4 (9.3-12.0)
X	X							8.3 (7.1-9.6)
	X		X					5.0 (4.0-5.9)
X		X			X			9.3 (9.1-11.8)
X		X		X				7.7 (7.5-10.0)
X		X				X		7.5 (6.4-8.7)
X				X	X			6.9 (5.9-8.1)
X				X		X		6.7 (5.7-7.9)
X		X		X	X			3.6 (2.9-4.5)
X		X			X	X		3.6 (2.8-4.4)
X		X		X		X		3.5 (2.7-4.4)
Prevalence, % with index disease only (95% CI)								
13.4 (11.6-15.7)	11.8 (8.3-16.2)	9.4 (7.5-11.8)	9.9 (6.0-15.2)	6.8 (4.8-9.2)	11.9 (9.5-14.6)	13.0 (10.4-16.0)	8.3 (5.7-11.7)	

For 2× disease combinations, the most prevalent disease combinations are shown for each disease or disease grouping and if the prevalence levels of a disease combination is ≥10%; for 3× disease combinations, those with a prevalence ≥5% are shown; for 4× disease combinations, those with a prevalence ≥2% are shown.
*Disease grouping.
CVD, cardiovascular disease; GI, gastrointestinal; HT, hypertension; MHP, mental health problem.

with an increase in mortality, but also that CVD associated with diabetes results in a twofold increase in mortality,[23] reinforces the importance of effective management of diabetes and CVD risk factors in the context of multimorbidity. In addition, mental health problems, in particular depression, are often thought of as a benign disease in terms of its effects on long-term health outcomes, including mortality. However, it is becoming increasingly evident that depression can have significant impact when comorbid with other chronic diseases. For example, when depression is comorbid with diabetes, it results in an increase in mortality by almost 40%,[24] and when comorbid with CVD results in an almost threefold increase in mortality.[25] This study highlights the need for greater awareness of the impact of mental health problems on long-term outcomes when comorbid with other chronic diseases. Ideally, this may then translate into appropriate treatment strategies for comorbid mental health problems.

We observed lower rates of mortality associated with arthritis, similar to that observed in a previous study with a younger cohort.[22] When osteoarthritis was present as a comorbid condition in people aged 55–64 years old, a 20–35% reduction in 5-year mortality was observed.[22] While several explanations have been proposed for the association of arthritis with lower mortality rates,[22] importantly we hypothesise that opportunity to receive care for specific diseases combinations is an important factor affecting survival. It is the "symptomatic" diseases, such as arthritis, that are more likely to result in those patients presenting to their primary care physician for treatment. As a consequence, it is these patients who will have a greater likelihood of earlier detection of other diseases and will be subsequently earlier managed. In contrast, patients with a disease such as CVD, whose first presentation is more commonly an acute episode, would be less likely to have other comorbid diseases detected and managed. In support of this, a recent study reported that patients with more conditions receive higher quality of care (an increased number of services recommended to them by their providers) than patients with fewer conditions,[26] potentially by virtue of increased opportunities for care. Further, in patients with diabetes, comorbidity, regardless of whether it shares the same pathophysiological mechanism, is proposed to increase a patient's overall health system use.[27]

In accord with previous results,[11] multimorbidity was associated with a decrease in self-rated health and ability to perform activities of daily living. Our study additionally shows that self-rated health is not dependent on the number of chronic diseases but more on the specific comorbid disease combinations. CVD and mental health problems were associated with poorer self-rated health, alone and when comorbid with other chronic diseases, and self-rated health decreased most when CVD and mental health problem were comorbid with one another. The effectiveness of self-rated health as a predictor of mortality in older people is well recognised,[28] and a recent meta-analysis of 22 cohort studies found that persons who reported "poor" self-

Table 3 Effect of specific chronic diseases or chronic disease groupings on self-rated health and activities of daily living*

Chronic disease grouping (n)	SRH, % poor or fair (95% CI)	ADL, % ≥1 (95% CI)
No chronic disease (266)	7.9 (5.1 to 11.8)	9.4 (6.2 to 13.4)
Arthritis (172)	14.4 (9.6 to 18.3)	13.3 (8.7 to 19.1)
GI disease (42)	16.3 (9.2 to 25.3)	3.5 (1.0 to 9.8)
HT (85)	13.9 (5.3 to 17.9)	4.7 (5.7 to 15.8)
Arthritis+GI disease (67)	25.0 (15.5 to 36.6)	12.5 (5.9 to 22.4)
Arthritis+HT (85)	20.4 (12.6 to 30.3)	14.8 (8.1 to 23.9)
Arthritis+GI disease+HT (29)	29.0 (14.2 to 46.0)	9.7 (2.0 to 25.7)
Cancer (40)	20.0 (9.1 to 35.6)	7.5 (1.6 to 20.4)
Cancer+arthritis (31)	25.0 (11.5 to 43.4)	12.5 (3.5 to 28.9)
Respiratory disease (41)	24.7 (13.2 to 40.3)	2.3 (0.6 to 12.0)
Respiratory disease+arthritis (26)	35.7 (18.6 to 55.9)	10.7 (2.3 to 28.2)
CVD (83)	29.7 (22.0 to 40.7)	14.3 (7.6 to 23.6)
CVD+arthritis (78)	30.0 (20.3 to 41.3)	17.5 (9.9 to 27.6)
CVD+GI disease (22)	17.3 (5.0 to 38.7)	13.0 (2.8 to 33.6)
CVD+HT (40)	36.6 (22.2 to 53.1)	17.1 (7.2 to 32.0)
CVD+arthritis+GI disease (28)	50.0 (31.3 to 68.7)	30.0 (14.7 to 49.4)
CVD+arthritis+HT (51)	34.0 (21.8 to 41.8)	12.5 (5.2 to 24.1)
CVD+arthritis+GI disease+HT (16)	44.4 (21.5 to 69.2)	33.3 (16.4 to 47.6)
MHP (31)	32.3 (16.7 to 51.3)	16.1 (5.4 to 33.7)
MHP+arthritis (43)	46.5 (31.2 to 62.3)	25.6 (13.5 to 41.2)
MHP+arthritis+GI disease (16)	50.0 (31.3 to 68.7)	30.0 (14.7 to 49.4)
MHP+CVD (12)	61.6 (31.5 to 86.1)	15.4 (19.2 to 45.4)
MHP+CVD+arthritis (14)	60.0 (32.3 to 83.6)	53.3 (26.5 to 78.7)
MHP+CVD+arthritis+GI disease (19)	75.0 (50.9 to 91.3)	33.3 (6.4 to 47.6)
MHP+CVD+arthritis+HT (14)	64.3 (35.1 to 87.2)	28.6 (8.3 to 58.1)
Diabetes (20)	20.0 (5.7 to 43.6)	15.0 (3.2 to 37.9)
Diabetes+arthritis (16)	18.8 (4.4 to 45.6)	6.3 (1.6 to 30.2)
Diabetes+CVD+arthritis (14)	57.2 (28.9 to 82.3)	21.4 (4.7 to 50.7)

*Mutually exclusive specific diseases or disease combinations.
ADL, activities of daily living; CVD, cardiovascular disease; GI, gastrointestinal; HT, hypertension; MHP, mental health problem; SRH, self-rated health.

rated health had a twofold increased of mortality compared with persons who reported "excellent" self-rated health.[29] From our study results, those chronic disease combinations that were associated with poorer survival time in general were also those disease combinations that resulted in poorer self-rated health.

Ideally, the results from this study need to be further validated in a larger cohort of older persons. We limited the number of morbidities to include only chronic diseases, in particular those that were highly prevalent and associated with significant disease burden in the population of older people. These chronic diseases represent high-priority conditions for healthcare worldwide,[30] in addition to being identified as Australian National Health Priorities.[31] However, by focusing on these "major" chronic diseases only, we may have underestimated the prevalence of multimorbidity and the impact of other chronic conditions that could have potentially affected quality of life and daily functioning (for example allergic rhinitis or vision problems), yet not necessarily mortality.

The data included in this study were based predominantly on patient self-report of chronic disease, apart from depression that was measured using the Centre for Epidemiological Studies-Depression Scale scale. While medical records are generally considered the "gold standard" of clinical data collection,[32 33] self-report of medical conditions is an important tool in epidemiology research and has been noted to be more appropriate for study at a population level rather than limited to just those individuals hospitalised or attending general practice.[34] In a recent Australian study, prevalence results for most chronic diseases were similar when reported from medical records by a general practitioner compared with a population-based Australian National Health Survey that uses self-report.[35]

Primary care physicians are the main providers of care for patients with multimorbidity,[36] and the chronic diseases included in this study account for the majority of chronic conditions managed at this level.[37] Given that the majority of older patients will present to their primary care physician with multimorbidity, our results highlight the need for a greater awareness for managing patients' overall health status within the context of multiple disease states rather than as a single disease entity. Patterns of care for those with multiple chronic diseases need to reflect a more patient-centred approach, integrating the individual needs of patients and their specific disease states. Patients with chronic diseases make daily decisions about

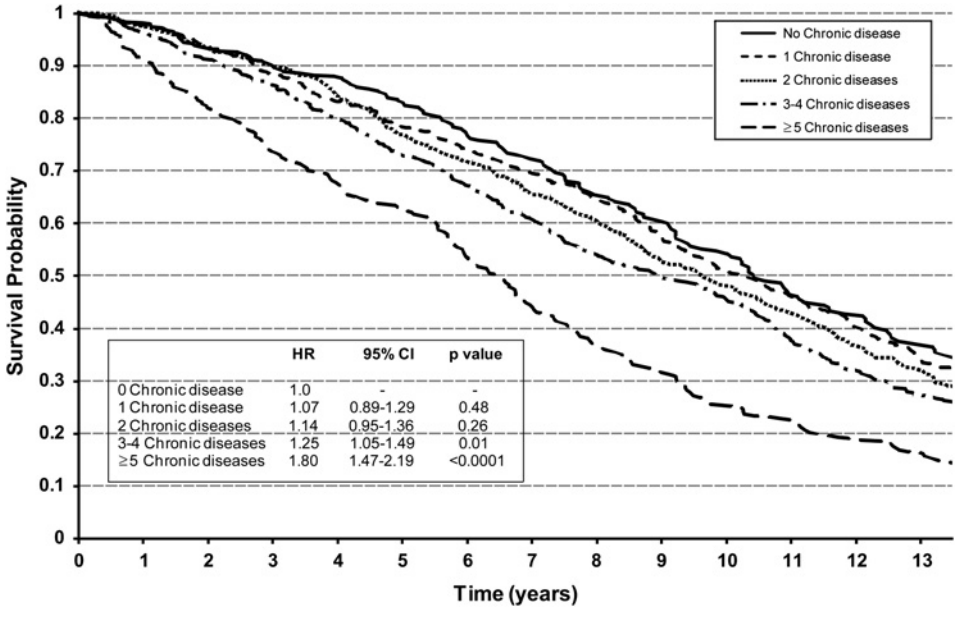

Figure 1 Adjusted survival curves classified according to number of chronic diseases at baseline over 14 years (adjusted for age, gender and residential status).

Table 4 Effect of specific chronic diseases or chronic disease groupings on median survival time*

Chronic disease grouping (n)	Median survival time, years (95% CI)
No chronic disease (266)	10.3 (9.1 to 11.6)
Arthritis (172)	11.9 (9.6 to 13.3)
GI disease (42)	11.3 (9.8 to ne†)
HT (85)	10.8 (9.0 to 13.7)
Arthritis+GI disease (67)	11.1 (9.6 to 12.6)
Arthritis+HT (85)	9.6 (8.4 to 12.7)
Arthritis+GI disease+HT (29)	12.3 (6.5 to ne†)
Cancer (40)	9.3 (7.1 to 10.3)
Cancer+arthritis (31)	7.4 (4.6 to 10.1)
Respiratory disease (41)	8.4 (6.8 to ne†)
Respiratory disease+arthritis (26)	9.6 (6.2 to ne†)
CVD (83)	6.9 (5.2 to 9.4)
CVD+arthritis (78)	8.2 (6.5 to 10.9)
CVD+GI disease (22)	5.2 (2.9 to 8.5)
CVD+HT (40)	6.5 (4.9 to 9.9)
CVD+arthritis+GI disease (28)	8.9 (5.9 to 12.2)
CVD+arthritis+HT (51)	9.8 (7.7 to 12.6)
CVD+arthritis+GI disease+HT (16)	7.6 (5.7 to ne†)
MHP (31)	6.0 (3.9 to 11.9)
MHP+arthritis (43)	9.5 (6.0 to 11.8)
MHP+arthritis+GI disease (16)	9.0 (6.1 to 13.6)
MHP+CVD (12)	5.4 (1.7 to 10.9)
MHP+CVD+arthritis (14)	5.2 (2.8 to 10.1)
MHP+CVD+arthritis+GI disease (19)	7.6 (4.3 to 10.3)
MHP+CVD+arthritis+HT (14)	5.4 (1.4 to 7.5)
Diabetes (20)	5.8 (4.6 to 10.8)
Diabetes+arthritis (16)	8.8 (6.0 to 11.9)
Diabetes+CVD+arthritis (14)	2.9 (2.0 to 11.7)

*Mutually exclusive specific diseases or disease combinations.
†Due to heavy censoring, the upper limit of the 95% CI could not be calculated.
CVD, cardiovascular disease; GI, gastrointestinal; HT, hypertension; MHP, mental health problem; ne, not estimable.

the management of their diseases,[38] and patient self-management is essential for effective chronic illness care and improved patient outcomes.[38 39] Multimorbidity can have profound effects on a patient's ability to self-manage their care. Similarly, medication adherence may also pose significant problems for patients' managing complex treatment regimens with multimorbidity.

Given the prevalence and burden associated with the chronic diseases examined in this study, our results have significant implications for the primary care physician in terms of the awareness and formulation of management and care strategies for multimorbid patients. Those disease combinations that are the most prevalent, or those that have the greatest impact on survival, should be targeted for the development of more appropriate treatment strategies. While the management of comorbid conditions needs to be included in future clinical guidelines, treatment decisions must remain individualised, incorporating evidence, clinical judgement and patient-specific information and circumstance. At present, the quality of healthcare for older persons with multiple chronic conditions is suboptimal and uncoordinated.[4 5] The development of appropriate and integrated processes of care for the multimorbid person is among the most critical issues healthcare systems face worldwide.

What is already known on this subject

- The prevalence of multiple chronic diseases is high (65—80%) in the population of older people and is associated with decreased quality of life, functional status and increased mortality.

What does this study add

- Older people with three or four chronic diseases have a 25% increased risk of mortality, while those with five or more chronic diseases have an 80% increased risk of mortality, by comparison to those with no chronic diseases.
- Mortality is dependent on what specific comorbid disease combinations are present within an individual, with CVD and mental health problems associated with increased mortality.

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