Population ageing and health care expenditure

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Contents

Chapter 1

General introduction

Population ageing and health care expenditure

National levels of health care spending are rising in many developed countries. Faced with increasing pressure on public finances, policy-makers are directing their attention towards the potential causes of this rise. Population ageing is perceived to be an important cause. For example, the Netherlands Bureau for Economic Policy Analysis estimated that population ageing caused 20% of the total rise in real health care expenditure (HCE) per capita in the Netherlands between 1972 and 2010.[1] Consequently, if this growth rate is extrapolated and other important factors are left aside – such as technological innovation, health policy restructuring and the Baumol effect[1] – population ageing will require Dutch citizens to spend 23% more on health care through taxes and premiums in 2040 than they did in 2010.

In contrast, other authors have found that population ageing only has a modest or even ignorable impact on health care costs.[2-4] They consistently find that technological innovations have been the major driver of growth in health care spending on the national level in recent decennia, and the demographic factors like population ageing play a minor or even insignificant role. Such contrasting results in literature on population ageing exist because population ageing itself is a complex dynamic involving many facets. Not only does a high degree of uncertainty surround these facets, many forecasts do not include all facets. In general, the term population ageing refers to three dynamics: (1) rising life expectancy; (2) a higher share of older people; and (3) increased mortality rates. These three dynamics have different implications for future health care spending, each with many different scenarios.

Rising life expectancy will only result in increased HCE if people will also live longer with health related problems. Otherwise, more life years will only postpone an increase in HCE. It is also possible that a higher life expectancy will dampen HCE (see next paragraph). Concerning the second dynamic, the share of older people is increasing and older people consume a relatively high share of health care. In 2007, Dutch citizens aged 65 years and older made up 15% of the total population, but were responsible for 37.5% of the total level of health care spending, equalling 27.75 billion of roughly

[1] The Baumol effect refers to an economic law, which stipulates that economic growth is logically accompanied by decreased efficiency in the public sector. The central idea is that increased labour productivity boosts economic growth, but that this increase in productivity is most pronounced in the private sector. Efficiency in the public sector then decreases because productivity lags behind that of the private sector while wages need to increase to prevent income disparity between these sectors.

74 billion euros.[5,6] When taking into consideration that the share of seniors is forecasted to rise up to 26% in 2040, there is prima facie evidence for a considerable impact of population ageing on HCE through this second dynamic (in this case, a rise from 74 billion to 88 billion from 2007 to 2040, equalling ±424 million euros annually). However, this simple extrapolation does not take the many counteracting dynamics into account, such as the 'red herring' phenomenon.[2]

The red herring phenomenon is related to the third dynamic: increased mortality rates. It refers to the notion that a strong rise in HCE by age on the population level conceals that there is actually not a strong rise in HCE by age on the individual level. On the individual level, in contrast, HCE increase only slightly with age, but rapidly before death. What then underlies the association between age and HCE on a population level is actually a rising mortality risk in combination with high 'costs of dying,' and **not** a presumed direct impact of age on HCE.[7] It is important to note here that the costs of dying decrease with age.[11] Economists therefore conclude that it is important to include predictions about age, mortality and the costs of dying in forecasts concerning HCE, rather than just age[8,9] – although some economic researchers do not agree with this point.[10,11]

Aim and outline of this thesis

To gain a better understanding of how the ageing of a population affects health care spending, it is important to investigate the three separate dynamics that underlie the association between HCE and population ageing. Therefore, the aim of this thesis is *to investigate the determinants of mortality, health care expenditure and the costs of dying in the older population.* The different determinants investigated in this thesis can be separated in two categories: (1) determinants that apply to the country as a whole (macro-level) – e.g. the status of the national economy; and (2) determinants relevant for the individual (micro-level) – e.g. a person's relationship status. Part I of this thesis (chapter 2–4) is dedicated to macro-level determinants, and part II (chapters 5–7) deals with the micro-level.

[2] The term 'red herring' refers to an illusionary tactic to draw one's attention away from the real problem. In economics, one creates a red herring when extrapolating a dependent variable without separately including **all** the possible determinants of the dependent variable in the forecasting model.

Overview of the chapters

Studies have found that rates in unemployment and economic growth affect the mortality rates of a population. It is unclear if and how economic growth is associated with mortality at older age. This is investigated in **chapter 2**. Another important macro-level determinant of mortality is seasonality. It is known that mortality rates of older people are higher in cold seasons and during heat waves, but it is unknown if seasonal cycles exist in medical care expenses and the institutionalization rates of older people. **Chapter 3** deals with this issue. **Chapter 4** focuses on the national health care system. Specifically, the idea that the effective use of general practitioners (GPs) can increase the cost-effectiveness of the national health care system is investigated. When GPs act as gatekeepers utilization of more expensive specialist care is avoided through selective referral, improved coordination, and the GPs ability to perform basic treatments at lower costs. However, the cost-effectiveness of such a gatekeeping system has not been studied properly.

Part II (the micro-level) starts with a chapter on personalized medicine. The care network surrounding frail older people is usually of a bureaucratic and complex nature, which comes at the expense of their health as well as the efficiency of regional health care supply. In **chapter 5** a programme is described that aims to improve the health of hospitalized frail older people by improving their network through the individual tailoring of care. Not only the structure of the formal care network is important for the health of the elderly patient, and the efficiency of health care of older patients: the informal care network is also of crucial importance. The most important part of an older person's care network is the spouse. It is known that married older people live in better health and have a lower mortality risk. The effect on marital status on HCE needs further exploration. The effect of the loss of the spouse on HCE through time is reported in **chapter 6**. Finally, **chapter 7** concerns the costs of dying. The focus lies on four determinants on which current literature is non-existent or controversial: variation in the cost of dying, and the role of socio-demographic characteristics, different health services, and preceding HCE in the costs of dying. The key findings of this thesis are discussed in **chapter 8**, which also concerns the impact of these findings on the debate about the impact of population ageing on HCE.

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Supplementary material

The Dutch health care system

Health care in the Netherlands can be separated into two main sectors: medical care and long-term care. Medical care refers to consultations, medication and treatment from general practitioners, medical specialists, dentists, pharmacists, and therapists (such as physiotherapists and psychotherapists). Some forms of instrumental aid and transportation are also provided through the medical care sector. In the studied time period, health care providers bill health care insurers in the form of diagnosis related groups. Medical care is legally arranged through the Health Insurance Act (HIA).

Long-term care in the Netherlands is legally arranged through the Exceptional Medical Expenses Act (EMEA). Entitled to care through the EMEA are people who cannot satisfy their basic care needs independently due to a physical, psychogeriatric or psychiatric ailment, or a mental, physical or sensorial handicap. Before someone may receive long-term care through the EMEA, the Center for Indication Setting has to evaluate the client's health status and issue an official indication. When an indication is set for a client, the actual provision of long-term care is arranged by so-called *care offices.* After an indication is set, the care office appoints a health care provider for a client, or distributes a personal budget. The health care insurer who has the highest share of clients in a region acts as the care office for that region.

There were basically five separate long-term care services funded through the EMEA in the studied time period: (1) personal care (e.g. dressing, undressing, help with bathing or showering), (2) nursing care (e.g. wound dressing), (3) counseling (daytime activities and help with improving self-reliance, individually tailored or in groups), (4) treatment (forms of rehabilitation or therapy) and (5) residence. Indications for extramural care are defined in type and level (hours per week). Since July 1st 2007, intramural care is indicated in terms of Care Weight Packages (CWPs). CWPs are pre-defined bundles of residential care, consisting of housing with different types of long-term care on different levels.

Part I

Determinants on the macro-level:
The national economy, climate & national policy

Chapter 2

Old age mortality and macroeconomic cycles

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Abstract

Background: As mortality is more and more concentrated at old age, it becomes critical to identify the determinants of old age mortality. It has counter-intuitively been found that mortality rates at all ages are higher during short-term increases in economic growth. Work-stress is found to be a contributing factor to this association, but cannot explain the association for the older, retired population.

Methods: Historical figures of gross domestic product (Angus Maddison) were compared with mortality rates (Human Mortality Database) of middle aged (40-44 years) and older people (70-74 years) in nineteen developed countries for the period 1950 through 2008. Regressions were performed on the de-trended data, accounting for autocorrelation, and aggregated using random effects models.

Results: Most countries show pro-cyclical associations between the economy and mortality, especially with regard to male mortality rates. On average, for every 1% increase in gross domestic product, mortality increases with 0.36% for 70-74 year old men ($p<.001$) and 0.38% for 40-44 year old men ($p<.001$). The effect for women is 0.18% for 70-74 year olds ($p=.012$) and 0.15% for 40-44 year olds ($p=.118$).

Conclusions: In developed countries, mortality rates increase during upward cycles in the economy, and decrease during downward cycles. This effect is similar for the older and middle aged population. Traditional explanations as work-stress and traffic accidents cannot explain our findings. Lower levels of social support and informal care by the working population during good economic times can play an important role, but this remains to be formally investigated.

Introduction

Life expectancy in developed countries is continuously on the rise.[1] A major part of the longevity increase was due to a mortality reduction at younger age, but is now mainly attributable to a reduction of old age mortality.[2,3] It is therefore important to investigate the determinants of old age mortality. Long-term economic growth is an important determinant of lower mortality rates of older people, as wealth creates health.[4-6] Since many developed countries are currently in a recession, one could expect this has a dampening effect on old age survival. However, it has been found that annual increases in unemployment, or decreases in gross domestic product (GDP), are associated with *lower* mortality rates at all ages. The association between macroeconomic cycles and mortality remains unknown. Since many developed countries are facing a recession, as well as a growing share of older people, there is a strong case to study the relation between macroeconomic cycles and old age mortality.

An association between mortality and short-term fluctuations in unemployment rates or GDP was found to exist in Germany,[7] Japan,[8] Mexico,[9] Spain,[10] Sweden[11,12] and the US.[13-17] Two papers analyzed the association in multiple countries, but only used age-standardized mortality rates.[18,19] The counter-intuitive association between the economy and mortality has been explained by increased job-related stress, higher risk of traffic accidents, and more unhealthy lifestyles during years of lower unemployment. Other explanations include lagged rather than concomitant effects (economic expansions diminish mortality rates, but with a delay)[20,21] or spurious correlation due to methodological issues.[22,23] Currently, the mechanisms underlying the association remain largely unknown. Of the aforementioned studies on mortality and short-term fluctuations in unemployment rates or GDP, a few considered old age mortality. Neumayer,[7] Tapia-granados,[10] Ruhm,[13] and Miller et al.[17] report that the association between short-term fluctuations in unemployment and mortality was also existent and relatively strong for older age categories, but further research is needed. Older, retired people will hardly be influenced by job-related stress, and they will not change their lifestyles as much as their younger working counterparts during different economic tides. All in all, older people are overlooked in many epidemiological studies on the association between the economic environment and mortality, and current explanations for the association do not suffice for older people. This is striking considering that many countries stand on the threshold of important demographic and financial changes.

The aim of the present study is to explore and analyze the association between macroeconomic cycles and cyclic variation in mortality rates of middle aged and older people. There are two main differences between our study and the aforementioned studies. First, rather than comparing mortality rates with annual fluctuations in unemployment or GDP, we compare cycles lasting several years. Second, we focus on old age mortality and compare this with a middle age working group. We also study this in a large group of countries, rather than in a single country. Other studies in multiple countries did not differentially study the older population.

Methods

Data collection

Data of gross domestic product per capita (GDP) and mortality of 19 developed countries between 1950 and 2008 were obtained from Angus Maddison's dataset and the Human Mortality Database respectively.[24] Maddison's dataset was used because it comprises data over a long period of time. To compare long cycles in the economy with changes in the trends of mortality, we considered that a dataset encompassing at least 50 years of data per country is required. The dataset offers estimated historical figures of GDP, defined as Geary-Khamis (G-K) dollars with purchasing power held constant with 1990 as the price level year. Geary and Khamis offered a credited alternative to price power parity adjusted figures of other economic institutes, such as the World Bank. Many studies on the association between the economy and mortality use unemployment as an indicator for a country's economic status, sometimes with income figures. We use GDP rather than unemployment for two reasons. First, only a few older people have jobs, so they are probably more directly influenced by changes in GDP rather than employment. Second, unemployment figures do not date back far enough to provide a long enough time frame.

Mortality rates were obtained from the Human Mortality Database for two age categories. The age group of 40 through 44 years old was chosen as the younger age group, because this group is chronologically in the middle of the working population of 20 to 60-65 years old. The older age group consists of people of 70 through 74 years old, who stand in the middle of the recently retired and the oldest old. The year 1950 is used as a starting point, because a dataset could then be collected that is up to date, large and does not suffer from the impact of two world wars and a recession in the interbellum. All 34 OECD countries were initially eligible for inclusion, but 14 countries were excluded because data concerning gross domestic product or mortality were unavailable for the selected time period.

Table 1. Population size, real GDP per capita, and mortality rates for both genders and two age groups for nineteen OECD-countries in 1950 and 2008.

	Population size (x1000)[a]		**Real GDP per capita**		**Mortality rates**							
					Age 70-74, male (%)		Age 70-74, female (%)		Age 40-44, male (%)		Age 40-44, female (%)	
	1950	2008	1950	2008	1950	2008	1950	2008	1950	2008	1950	2008
Australia[b]	8,267	20,750	7,412	25,301	6.54	2.28	4.28	1.38	.40	.15	.32	.10
Austria	6,935	8,206	3,706	24,131	6.60	2.65	4.97	1.40	.46	.16	.34	.08
Belgium	8,639	10,404	5,462	23,655	7.91	2.41	5.66	1.05	.72	.16	.60	.09
Canada[b]	14,011	32,936	7,291	25,267	5.47	2.67	4.25	1.67	.40	.16	.31	.10
Denmark	4,271	5,485	6,943	24,621	5.18	3.24	4.62	2.15	.29	.18	.26	.12
Finland	4,009	5,245	4,253	24,344	7.59	2.90	5.58	1.41	.65	.26	.33	.10
France[b]	42,518	63,682	5,186	22,223	6.43	2.58	4.37	1.20	.54	.23	.33	.11
Ireland	2,963	4,518	3,453	27,898	6.28	3.02	5.31	1.69	.47	.16	.45	.10
Italy[b]	47,105	59,627	2,881	19,909	5.40	2.61	4.67	1.32	.43	.14	.30	.08
Japan	83,805	127,788	1,921	22,816	7.91	2.41	5.66	1.05	.72	.16	.60	.09
Netherlands	10,121	16,410	3,502	24,695	4.70	2.80	4.33	1.63	.26	.14	.22	.10
N. Zealand	1,908	4,173	8,456	25,267	5.91	2.50	4.08	1.74	.31	.16	.29	.11
Norway	3,265	4,644	5,996	28,500	4.34	2.64	3.75	1.57	.30	.15	.21	.08
Portugal	8,443	10,677	2,086	14,436	6.90	3.02	4.91	1.54	.70	.28	.43	.12
Spain[c]	28,063	44,432	2,189	19,706	6.60	2.81	5.04	1.27	.59	.21	.40	.10
Sweden	7,014	9,045	6,769	24,409	5.07	2.51	4.54	1.49	.28	.13	.25	.09
Switzerland[b]	4,694	7,555	9,064	25,104	6.15	2.37	4.54	1.29	.38	.14	.28	.08
UK	50,127	61,643	6,939	23,742	6.71	2.84	4.63	1.85	.37	.19	.28	.12
USA[b]	157,868	301,580	9,561	31,178	6.02	3.02	4.28	2.03	.53	.28	.35	.17

[a] Population data is from the US Census Bureau. [b] Data available until 2007. [c] Data available until 2006.

In addition, Hungary was excluded because of methodological issues (see statistical analysis) and a turbulent historic background – including repression, revolution, and the shift from a plan economy into a capitalist economy. Characteristics of the nineteen included countries are shown in table 1.

Statistical analysis

To capture cyclical variation in the economy and mortality, we transformed real figures of gross domestic product and mortality rates into percentual deviations around the long-term trend. The long-term trend of GDP is expressed as the log-linear function

$$\log GDP = \alpha + \beta * Y + \varepsilon$$

where GDP stands for gross domestic product, α for the intercept, β for the regression coefficient, Y for year (1950-2008), and ε for the error term. Using this method, the constant growth or decline rate is filtered out to retrieve the cyclic movements around its long-term trend and prevent interference from the trend itself. The average fit (R^2) of all log-linear functions for GDP and mortality in the 19 included countries was 0.89. Hungary was excluded, in part because of the low fit of the long-term trends (R^2=0.47). Figure 1 portrays figures of GDP (a) and mortality (b) as well as their long-term trends for the Netherlands from 1950 through 2008. In both panels, the arrow shows an example of a deviation. In previous literature, authors comparing GDP and mortality often use deviations from the Hodrick-Prescott trend.

Separate analyses were performed for each country, gender and age group. Percentual deviations from the long-term trend are calculated by subtracting the log-linear function from the real figures, and expressing this value as a percentage of the log-linear function. In each separate analysis, deviations of mortality are regressed on deviations of GDP in a linear regression model. Due to their cyclic nature, data in subsequent years are likely to be correlated: standard regressions would therefore underestimate uncertainty. Instead, we used Cochrane–Orcutt regression to account for autocorrelation and calculated Durbin-Watson test statistics.

The separate analyses were aggregated over all countries using a meta-analysis with a random effects model for continuous variables: the overall coefficients with confidence intervals were estimated from the separate estimated coefficients and standard errors for the nineteen countries.[25] Data transformations were performed in SPSS 21.0. All statistical analyses were performed using Stata/IC 9.2.

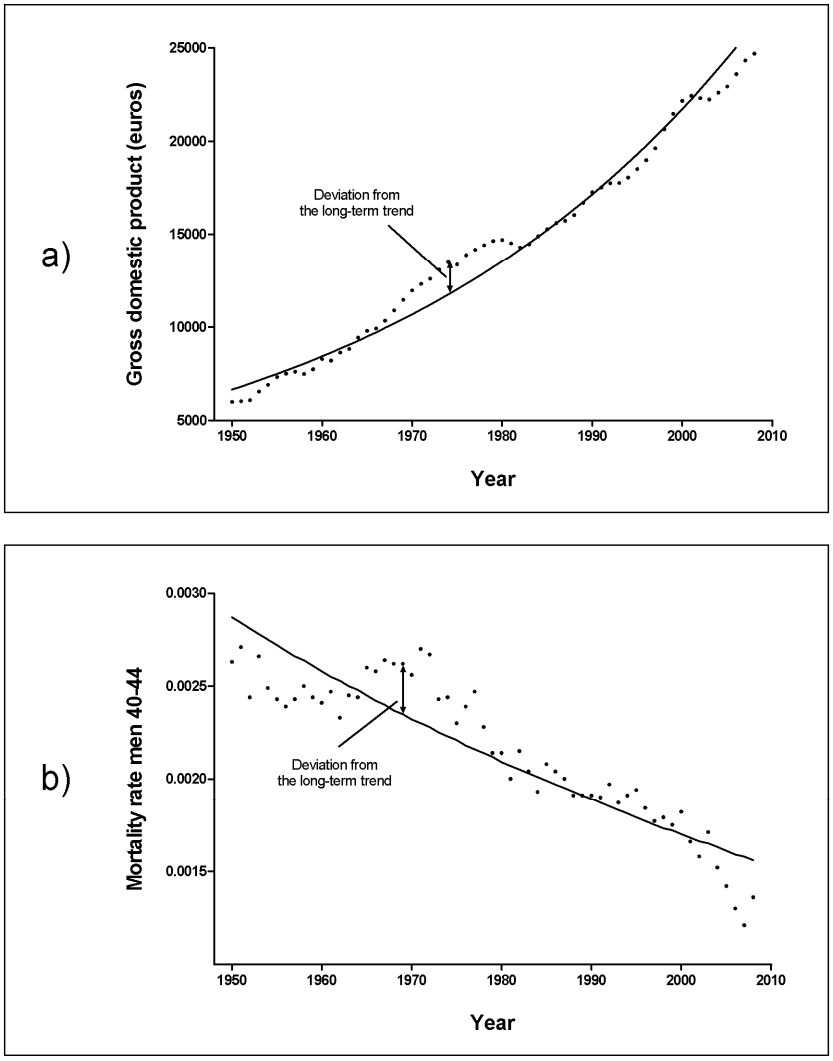

Figure 1. Macroeconomic cycles and cylical variation in mortality, the Netherlands 1950-2008: Example of the methods. Shown are real figures and long-term trends (log-linear functions) of gross domestic product (a) and mortality rates (b). The arrow portrayed in both panels shows an example of a deviation from the long-term trend.

Results

Autocorrelation properties

According to the Durbin-Watson test statistic,[26] 70 of the 76 analyses (4 groups in 19 countries) show signs of autocorrelation. After applying the Cochrane-Orcutt method only seven associations still showed signs of autocorrelation. The following results are all adjusted for autocorrelation.

Macroeconomic cycles and mortality

In the long term, an increase in gross domestic product (GDP) is associated with a decrease in mortality in all countries. However, the cycles around the trends in GDP and mortality show a different association. An example of the association is given in figure 2. Here, percentual deviations from the trend for GDP and mortality in men aged 40-44 are shown for the Netherlands from 1950 through 2008. The deviations in GDP and mortality show a parallel, or pro-cyclical, movement. This means that mortality rises in the Netherlands when its economy is in an upward cycle, or in other words, when the economy expands.

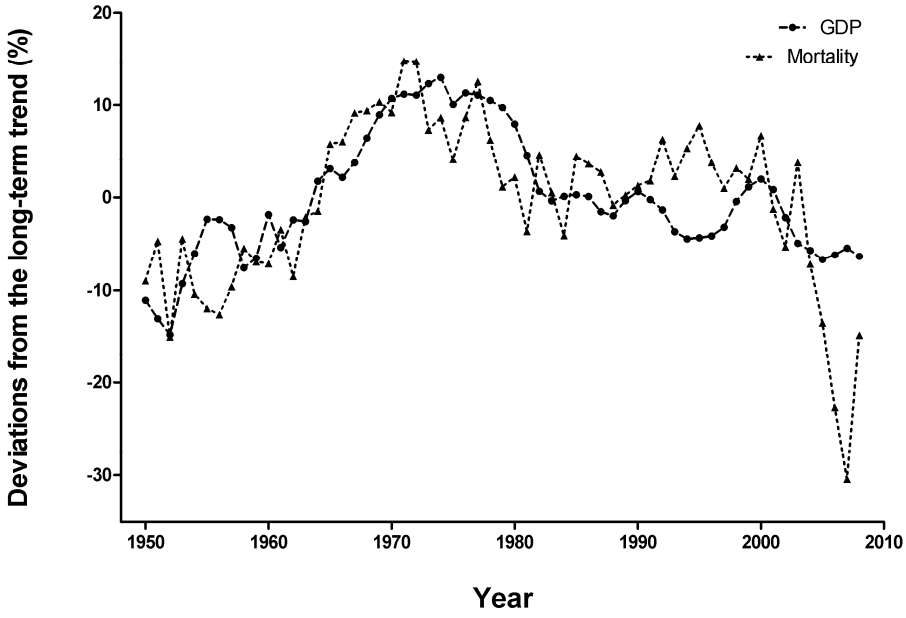

Figure 2. Parallel movement between macroeconomic cycles and cyclical variation in mortality in the Netherlands from 1950 through 2008. Cyclical variation in gross domestic product (GDP) and mortality are defined as percentual deviations from the long-term trend.

The forest plots in figure 3 summarize the associations between macroeconomic cycles and cyclical variation in mortality for all the analyzed countries. The means, confidence intervals, and significance levels of the associations are presented in supplementary table 1 (page 29). The coefficients in the forest plots reflect the change in percentual deviations from the long-term trend for mortality with every 1% change in deviations of the country's GDP. A positive coefficient thus stands for a pro-cyclical association, whereby mortality increases during economic expansion.

For males aged 70 through 74, mortality rates increase in 17 of the 18 countries when the economy expands (analysis for men aged 40-44 in Norway could not be performed, since transformation of autocorrelation properties was not possible). Of these pro-cyclical associations seven are significant. On average, mortality in older males show an increase of 0.36% (CI 95% 0.22 to 0.50; p<.001) for every one percent the macroeconomic cycle moves upward. For the middle age male group, mortality rates in 16 countries also show a pro-cyclical movement, of which seven are significant. On average, mortality trends of males age 40-44 increase with 0.38% (CI 95% 0.19 to 0.56; p<.001) for every percent the economy expands.

For females aged 70 through 74 (figure 3), mortality rates increase in 16 countries when the economy expands. Seven of these pro-cyclical associations are significant. The remaining three anti-cyclical associations are all significant (Canada, Ireland and Sweden). On average, mortality for this age group increases with 0.18% (95% CI 0.04 to 0.32; p=.012) when the macroeconomic cycle moves upward with 1%. Mortality rates of females age 40 through 44 show a pro-cyclical association in 12 countries, of which six are significant. Of the seven anti-cyclical associations, two are significant (Finland and Japan). On average, mortality trends of females age 40-44 increase with 0.15% (CI 95% -0.04 to 0.34; p=.118) for every percent the macroeconomic cycle goes upwards.

It is plausible that a pro-cyclical movement between the economy and mortality exists. Gerdtham and Ruhm have found that a 1% decrease in unemployment is associated with a 0.4% increase in cardiovascular disease, 1.1% in influenza/pneumonia, 1.8% in liver disease, 2.1% in motor vehicle deaths, and 0.8% in other accidents.[18] Lower unemployment rates during downward cycles in gross domestic product can induce these job-related stress factors. However, direct job-related factors do not explain our finding that older people react at least similarly to changes in the economy as middle age people. It is known that air pollution increases during economic expansions,[27] but evidence for a relation with mortality in older people is lacking.

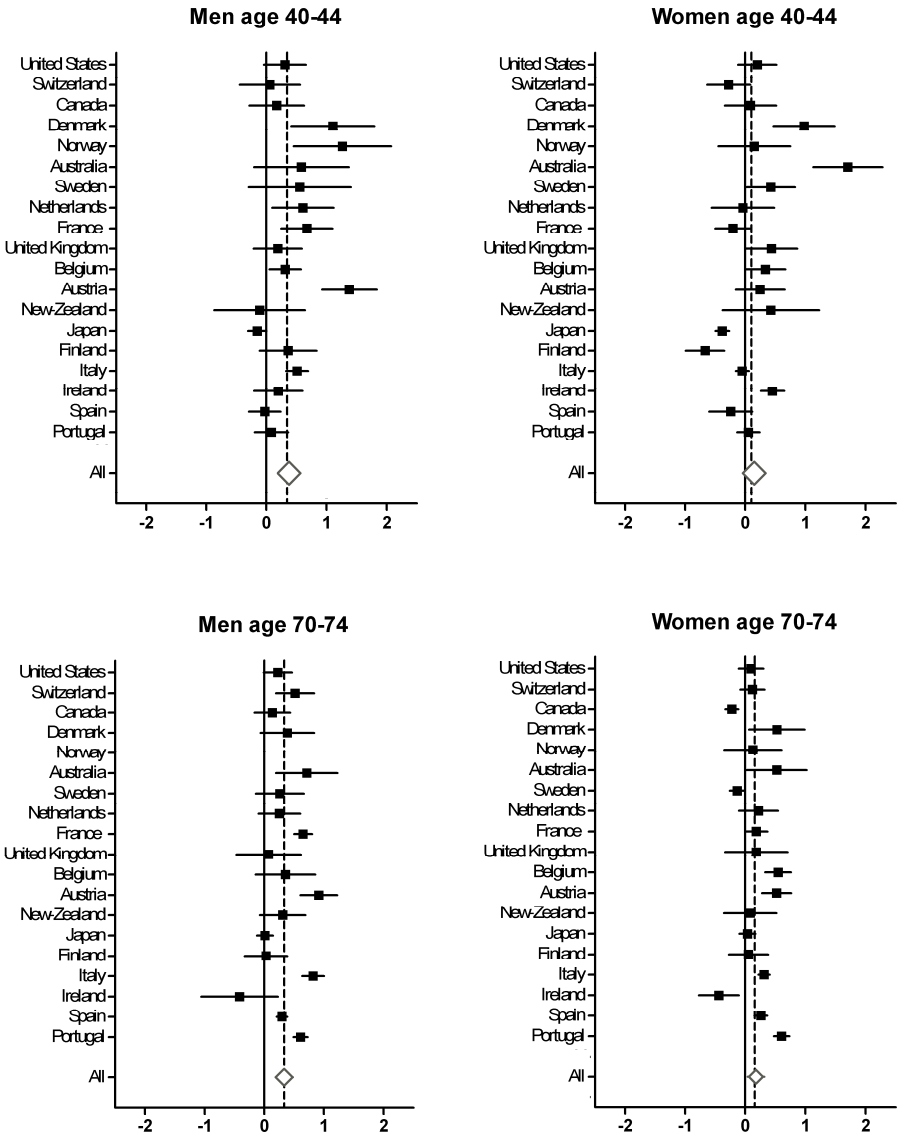

Figure 3. Associations between macroeconomic cycles and cyclical variation in mortality. Shown are associations of a 1% rise in the macroeconomic cycle with a change in the cyclical variation of mortality. A positive coefficient shows that mortality rises during economic expansion, and lowers during economic downturns. Estimates are coefficients from a linear regression model with corresponding 95% confidence intervals. Open symbols represent the weighted average and 95% confidence interval as derived from a random effects model. The association for men age 40-44 in Norway is missing, because the transformation of autocorrelation properties was not possible.

Furthermore, air pollution doesn't explain why men suffer more during good economic times than women. It could be that other factors are at play at higher ages. For example, changes in social support can have a considerable impact on old age mortality.[28-31] When employment rates and the amounts of workload increase for the working population, it is plausible that there is less time for informal care-giving by younger relatives and friends for the chronically ill or oldest old. Also, the non-working older partner can be overburdened with informal care when the working children have less spare time, leading to higher mortality in the older care-giver group.[32]

Another possible explanation of the first kind is of a psychosocial nature, known as the inhibition effect.[22] Studies show that persons who remain employed during times of higher unemployment reduce their alcohol consumption, and exhibit less antisocial behavior.[33,34] Also, the number of road accidents and other traumas decreases with higher unemployment, although suicide and homicide rates increase.[35,36] Ruhm found that during times of lower unemployment smoking and obesity figures increase, diets become more unhealthy, and physical exercise decreases.[14] It could be that older people show the same kind of inhibition effect during downward cycles in the economy. The effect might even be stronger for pensioners, because they do not have the effect of increased risk of mortality by unemployment to counterbalance the inhibition effect. On the other hand, older people are less inclined to show this kind of behavior on the basis of changes in gross domestic product, since they are less dependent on the economy than employed or job-seeking individuals. Also, unhealthy lifestyles usually do not result in increased mortality risk immediately, but some years later.

Secondly, one could also argue for reversed causality and that changes in mortality rates influence economic variables. Macroeconomic cycles are partly dependent on shifts in the demographic composition of a country, such as immigration and labor force supply. Taking this point of view, one could argue that old age mortality influences the economy. If mortality rates of the non-working population increase relative to those of the working population, average figures of labor productivity per capita will increase, raising per capita figures of gross domestic product.

Thirdly, economic expansions may decrease mortality with a delay. What seems as concomitant variation on first sight, could be a lagged reversed causal relation in reality. Some authors propose this delayed effect is the true dynamic behind the found effect of short-term fluctuations in the economy and mortality.[20,21] However, graphs comparing deviations in gross domestic product and mortality for the nineteen investigated countries show that cycles move in a concomitant fashion, and no lag effects can be detected.

Finally, there could be a spurious association between economic and mortality figures.[22-23] In this case, methodological issues in time-series analyses, or the existence of a third variable, are at play. Concerning methodological issues, we tried to avoid an important caveat by adjusting for autocorrelation. Concerning a third variable, many determinants or even confounders could cause changes in economic and mortality figures, such as health policies, air pollution, or informal care. To acquire enough data to analyze macroeconomic cycles, a dataset comprising many years was needed. More specific data on potential explanatory variables were not available for the selected time period. Furthermore, data about underlying causes of mortality rates are available through the OECD, but these data are only available for age-standardized mortality rates, and not age-specific mortality rates.

This implies that further research with the inclusions of such omitted variables is needed to unravel the seemingly pro-cyclical association between the economy and mortality in developed countries. Especially panel studies could greatly contribute to our understanding of the dynamics behind the association. This applies especially for explaining changes in mortality trends of older people, where current explanations do not suffice. Another limitation of our broad dataset is that the many differences between the here included countries could not be analyzed. We included all countries for which figures of gross domestic product and mortality were known from 1950 onwards, without paying attention to, for example, the differences in demographic composition or culture. The statistically significant reversed relationship we found for women in some countries suggest that there is heterogeneity among the countries.

A strong aspect of this study is that we are the first to compare long cycles in gross domestic product and cyclical variation in mortality. Earlier studies on the association between the economic environment and mortality have focused on short-term fluctuations in unemployment or gross domestic product. Furthermore, our analysis includes a very comprehensive dataset with economic and mortality figures in over 50 years for nineteen developed countries. Earlier studies analyzing multiple countries use age-standardized mortality rates only.

The counter-intuitive association between macroeconomic cycles and cyclical variation in mortality needs further explanation. So far, the most plausible explanations have been labor-related, but these cannot explain the similar associations we found among older people. Higher levels of air pollution and lower levels of informal care and social support during good economic times could be major contributors to the association, but the evidence on the existence of such dynamics is scant. In times of economic turmoil and population ageing, further exploration of the effects the economic environment can have on the well-being of older people is of great importance.

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Supplementary material

Supplementary table 1. Associations between macroeconomic cycles and cyclical variation in mortality, by country, sex and age group. Shown are associations of a 1% rise in the macroeconomic cycle with a change in the cyclical variation of mortality, together with the 95% confidence interval (Ci). Estimates are coefficients from a linear regression model with corresponding 95% CI.

	Men 40–44	**Men 70–74**	**Women 40–44**	**Women 70–74**
United States	0.31 (−0.04 to 0.66)	0.23 (−0.01 to 0.46)	0.10 (−0.11 to 0.30)	−0.47 (−1.03 to 0.09)
Switzerland	0.06 (−0.45 to 0.56)	0.52 (0.20 to 0.84)**	−0.28 (−0.64 to 0.08)	0.12 (−0.08 to 0.32)
Canada	0.17 (−0.29 to 0.63)	0.13 (−0.16 to 0.43)	0.09 (−0.34 to 0.51)	−0.22 (−0.33 to −0.11)***
Denmark	1.10 (0.41 to 1.80)**	0.39 (−0.06 to 0.84)	0.98 (0.47 to 1.48)***	0.52 (0.06 to 0.99)*
Norway	1.26 (0.45 to 2.07)**	NA[a]	0.15 (−0.45 to 0.75)	0.13 (−0.35 to 0.61)
Australia	0.58 (−0.21 to 1.37)	0.71 (0.19 to 0.23)**	1.71 (1.13 to 2.28)***	0.52 (0.02 to 1.02)*
Sweden	0.55 (−0.30 to 1.40)	0.26 (−0.14 to 0.66)	0.43 (0.02 to 0.83)*	−0.13 (−0.26 to −0.01)*
Netherlands	0.60 (0.09 to 1.12)*	0.25 (−0.10 to 0.61)	−0.04 (−0.56 to 0.48)	0.22 (−0.11 to 0.54)
France	0.67 (0.24 to 1.10)**	0.65 (0.50 to 0.80)***	−0.21 (−0.50 to 0.09)	0.18 (−0.01 to 0.37)
UK	0.19 (−0.21 to 0.59)	0.07 (−0.47 to 0.62)	0.43 (0.01 to 0.86)*	0.18 (−0.33 to 0.70)
Belgium	0.31 (0.05 to 0.57)*	0.35 (−0.15 to 0.86)	0.34 (0.01 to 0.67)*	0.54 (0.33 to 0.76)***
Austria	1.38 (0.92 to 1.83)***	0.91 (0.60 to 1.22)***	0.25 (−0.16 to 0.65)	0.52 (0.27 to 0.76)***
New Zealand	−0.11 (0.87 to 0.64)	0.31 (−0.08 to 0.69)	0.42 (−0.38 to 1.23)	0.08 (−0.36 to 0.52)
Japan	−0.15 (−0.31 to 0.01)	0.01 (−0.12 to 0.14)	−0.38 (−0.50 to −0.27)***	0.04 (−0.10 to 0.17)
Finland	0.36 (−0.11 to 0.83)	0.03 (−0.33 to 0.39)	−0.67 (−0.99 to −0.35)***	0.05 (−0.28 to 0.38)
Italy	0.51 (0.32 to 0.70)***	0.82 (0.63 to 1.00)***	−0.05 (−0.16 to 0.06)	0.31 (0.22 to 0.41)***
Ireland	0.20 (−0.21 to 0.60)	−0.41 (−1.06 to 0.23)	0.45 (0.26 to 0.64)***	−0.44 (−0.77 to −0.11)*
Spain	−0.03 (−0.29 to 0.24)	0.30 (0.21 to 0.39)***	−0.24 (−0.60 to 0.12)	0.26 (0.15 to 0.36)***
Portugal	0.08 (−0.20 to 0.36)	0.61 (0.49 to 0.73)***	0.05 (−0.14 to 0.24)	0.60 (0.47 to 0.73)***
All countries	**0.38 (0.19 to 0.56)*** **	**0.36 (0.22 to 0.50)*** **	**0.15 (−0.04 to 0.34)**	**0.18 (0.04 to 0.32)* **

*=p<.05; **=p<.01;***=p<.001

[a] The regression analysis for men 70–74 could not be performed for Norway, as conversion of autocorrelation was not possible.

Chapter 3

Seasonal variation in mortality, medical care expenditure and institutionalization in older people

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Seasonal variation in mortality, medical care expenditure and institutionalization in older people: Evidence from a Dutch cohort of older health insurance clients
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Abstract

Background: The mortality rates of older people changes with the seasons. However, it has not been properly investigated whether the seasons affect medical care expenditure (MCE) and institutionalization. Seasonal variation in MCE is plausible, as MCE rises exponentially before death. It is therefore important to investigate the impact of the seasons on MCE, either separate from mortality or not.

Methods: Data on mortality, MCE and institutionalization from people aged 65 and older in a region in the Netherlands from July 2007 through 2010 were retrieved from a regional health care insurer and were linked with data from the Netherlands Institute for Social Research, and Statistics Netherlands (n=61,495). The Seasonal and Trend decomposition using Loess (STL) method was used to divide mortality rates, MCE, and institutionalization rates into a long-term trend, seasonal variation, and remaining variation. For every season we calculated the 95% confidence interval compared to the long-term trend using Welch's t-test.

Results: The mortality rates of older people differ significantly between the seasons, and are 21% higher in the winter compared to the summer. MCE rises with 13% from the summer to the winter; this seasonal difference is higher for the non-deceased than for the deceased group (14% vs. 6%). Seasonal variation in mortality is more pronounced in men and people in residential care. Seasonal variation in MCE is more pronounced in women. Institutionalization rates are significantly higher in the winter, but the other seasons show no significant impact.

Conclusions: Seasonal changes affect mortality and the level of MCE of older people; institutionalization rates peak in the winter. Seasonal variation in MCE exists independently from patterns in mortality. Seasonal variation in mortality is similar for both institutionalized and community-dwelling elderly. Policy-makers, epidemiologists and health economists are urged to acknowledge and include the impact of the seasons in future policy and research.

Introduction

Developed countries are faced with ageing populations and increasing health care expenses. Investigating the determinants of health care expenditure in the older population is therefore of high importance. Many epidemiological studies show that there is seasonal variation in mortality,[1-16] but whether medical care expenditure (MCE) also shows seasonal variation has not been formally investigated. Since individual levels of MCE rise steeply prior to death,[17-22] it seems only logical that – as a direct result of seasonal variation in mortality – there is seasonal variation in MCE. However, the level of MCE may also change with the seasons due to changes in non-fatal forms of morbidity. It is therefore tempting to study seasonal differences in older people's health also by focusing on changes in health care utilization and expenditure separately for individuals who died and those who survived.

It has been found that mortality rates in the older population rise during winter time in Europe,[8-10,16] the US,[6] and low and middle income countries,[5,12] and New-Zealand.[4] Summers are also associated with higher mortality rates.[2,3,6,11] A very recent multi-country investigation shows that mortality rates gradually increase with colder temperatures, but also show a sudden increase when excessive heat occurs.[7] Many different factors are thought to underlie the association between ambient temperature and morbidity and mortality, such as changes in the risk cardiovascular events,[23,24] susceptibility to infectious diseases,[14,25,26] and the risk of incurring a hip fracture.[27] The occurrence of more strokes and hip fractures during cold seasons implies that the demand for institutional care is higher during these seasons. Some studies find that the effect of seasonal variation is more prominent in women than men.[4,9,16] Socioeconomic differences did not influence the associations.[8,15]

Here, we study the effect of the seasons on MCE and institutionalization (viz., admittance to a care or nursing home). We aim to answer two research questions: (1) is there seasonal variation in mortality rates, medical care expenditure (MCE), and institutionalization rates (admission rates to care and nursing homes) in Dutch people aged 65 years or older?; and (2) does seasonal variation in mortality rates, MCE and/or institutionalization rates differ between subgroups, based on gender, age, vital status (close to death or not), and residential status (institutionalized vs. community-dwelling)? We use the 'STL decomposition method' to detect a possible seasonal variation in the different measures. This method divides the data into a long-term trend, seasonal variation around the long-term trend, and 'remaining' variation. For the second research question we divide the study population into different subgroups.

Methods

The Dutch health care system

Health care in the Netherlands can be separated into two main sectors: medical care and long-term care. Medical care refers to consultations, medication and treatment from general practitioners, medical specialists, dentists, pharmacists, and therapists (such as physiotherapists and psychotherapists). Some forms of instrumental aid and transportation are also provided through the medical care sector. In the studied time period, health care providers bill health care insurers in the form of diagnosis related groups. Medical care is legally arranged through the Health Insurance Act (HIA).

Long-term care in the Netherlands is legally arranged through the Exceptional Medical Expenses Act (EMEA). Entitled to care through the EMEA are people who cannot provide in their basic care needs independently due to a physical, psychogeriatric or psychiatric ailment, or a mental, physical or sensorial handicap. Before someone may receive long-term care through the EMEA, the Center for Indication Setting has to evaluate the client's health status and issue an official indication. When an indication is set for a client, the actual provision of long-term care is arranged by so-called *care offices.* After an indication is set, the care office appoints a health care provider for a client, or distributes a personal budget. The health care insurer who has the highest share of clients in a region acts as the care office for that region.

Indications for residential care are defined in type and level (hours per week). Since July 1st 2007, residential care is indicated in terms of Care Weight Packages (CWPs). CWPs are pre-defined bundles of care, consisting of different types of long-term care on different levels, complemented with residence. From July 2007 through December 2010, residential care was categorized into ten CWPs: the first four relate to different types of residential care in care homes, the second four to nursing homes, the 9th to rehabilitation, and the 10th to palliative care.

Ethics statement

After consulting the internal review board (IRB) of the regional health insurer, data on health care expenditure were retrieved from a health insurer. A formal waiver of IRB approval was received from Statistics Netherlands (*Centraal Bureau van de Statistiek*) for data collection. After consulting the IRB of Statistics Netherlands, a single transfer of data from the health insurer to Statistics Netherlands was undertaken over a secure line. A formal waiver was received by the IRB of Statistics Netherlands. After the data transfer, the Statistics Netherlands first removed any personal data. The leading author

could then only access the de-identified data in a secured room of Statistics Netherlands. The authors had no access to identifying information. Any output destined for publication was first scrutinized by the IRB of Statistics Netherlands, so no output could be traced back to individuals. No data are publicly available. Data collection and analysis was in full accordance with privacy legislation and protocol.

Data

With the aim to perform multiple studies on the association between the life situation of older people and their health care expenses, the *Leiden Health care Costs in Old Age* (LHCOA) study was started in 2011. For this study, data on health care expenses of 61,495 people aged 65 and older in a period of 42 months were retrieved from a regional Dutch health insurance company and matched with data on socio-economic characteristics from Statistics Netherlands. Data were collected using the following steps:

1. After consulting the IRB (legal department) of the regional health insurance company, data on MCE were retrieved from the management information system of the health insurance company. Data were collected for the period July 2007 through 2010 for all persons who lived in the regions where the health care insurer acted as the long-term care office, and who reached the age of 65 before 2011. Addresses were linked with data on socio-economic status by postal code, provided by the Netherlands Institute for Social Research
2. In accordance with the IRB of the health insurance company, data on long-term care utilization were collected from the EMEA Care Registration system (ECR), an information system which offers an oversight of all the coded messages that are sent between organizations active within the confounds of the EMEA. ECR messages designating the start and end of long-term care provision were used to determine whether a client was institutionalized. Institutionalization rate was defined as the admission rate to care and nursing homes.
3. After consulting the IRB of Statistics Netherlands a single transfer of data from the health insurer to Statistics Netherlands was done over a secure line. CBS staff merged the data using citizen service numbers and dismissed any personal data afterwards. The authors could then only access the de-identified data in a secured room of Statistics Netherlands. The authors had no access to identifying information. Any output destined for publication was first scrutinized by the IRB of Statistics Netherlands, so no output could be traced back to individuals. Data collection and analysis was in full accordance with privacy legislation and protocol. Socio-demographic variables collected at Statistics Netherlands were: age, gender, marital status, and time of death.

The total study population of the LHCOA study (n=61,495) was used to investigate the association between the seasons and mortality, medical care expenditure (MCE) and institutionalization rate. If an association between seasonal change and mortality as well as MCE is found, it will be unclear whether the association with MCE is caused by mortality in combination with the high costs of dying, or whether there is a direct association between seasonal changes and MCE. Therefore, the total study population was divided into two groups: subjects who died before 2012 (n=9,202), and those that survived until 2012 (n=52,293). If an association between seasonal changes and MCE exists in the survivor group, there is evidence for a direct association, separate from mortality rates and the costs of dying.

Besides splitting up the study population into a deceased and non-deceased group, we also separated subgroups on the basis of age, gender, and residential status. We divided the population in community-dwellers and institutionalized subjects to further investigate the link between mortality and outside temperature. Institutionalized subjects were admitted in a care home or nursing home and were therefore predominantly or even exclusively exposed to a constant inside temperature. If there is also seasonal variation in mortality for the institutionalized, it is plausible that seasonal variation is caused by other factors than temperature alone.

Statistical analysis

Seasons represent three-monthly periods. In the Netherlands, the winter season officially starts on December 21st and ends on March 20th. Therefore, winter data were defined as January, February and March. Spring, summer and autumn were defined using the subsequent three monthly periods.

The Seasonal and Trend decomposition using Loess (STL) method was used to analyse seasonal variation in mortality risk, MCE, and institutionalization rate. The STL method decomposes longitudinal data into a long-term trend, seasonal variation, and remaining variation that does not stem from the long-term trend or from seasonal variation.[28] The long-term trend in the STL method reflects an array of possible external factors that gradually change over time, such as higher average ages, an increased risk of widowhood, changes in health care policy, and inflation. Our aim is to find whether seasonal changes are a significant component in the actual data. For every season we calculated the 95% confidence interval compared to the long-term trend using Welch's t-test. The R statistical programming language was used for the STL decomposition.

Results

Table 1 shows the characteristics of the study population. The study population includes 61,495 subjects aged 65 years and older, with an average follow-up of 35.7 months. Socio-demographic characteristics are shown for the first month of follow-up. Also shown is the number of deaths and institutionalizations during follow-up.

Table 1. Characteristics of the study population.[a]

	n (%)	
All subjects	**61,495**	
Gender		
Men	24,904	(41)
Women	36,591	(59)
Age		
65-79	49,438	(80)
80+	12,057	(20)
Marital status		
Married	35,082	(57)
Not married	26,413	(43)
Residential status		
Community-dwelling	61,130	(99)
Institutionalized	365	(1)
During follow-up[b]		
Deceased	7,040	(11)
Institutionalized	7,223	(12)

[a] Data on these characteristics refer to the first month of follow-up.
[b] Average individual follow-up is 35.7 months.

Figure 1 visualizes the number of deaths, the level of medical care expenditure (MCE), and the number of institutionalizations of the study population, as well as the long-term trends and seasonal cycles around the long-term trends of these variables. The long-term trend is portrayed with a dotted line, and the seasonal cycles around the long-term trend are shown with a solid line. There is a strong long-term trend in institutionalization rate (panel C) between autumn 2007 and autumn 2011. The number of institutionalizations per 10,000 persons for every season rises from 46 in the summer of 2007 to 75 in the winter of 2009. Hereafter, the number slowly decreases towards 62 institutionalizations per 10,000 persons in the autumn of 2010.

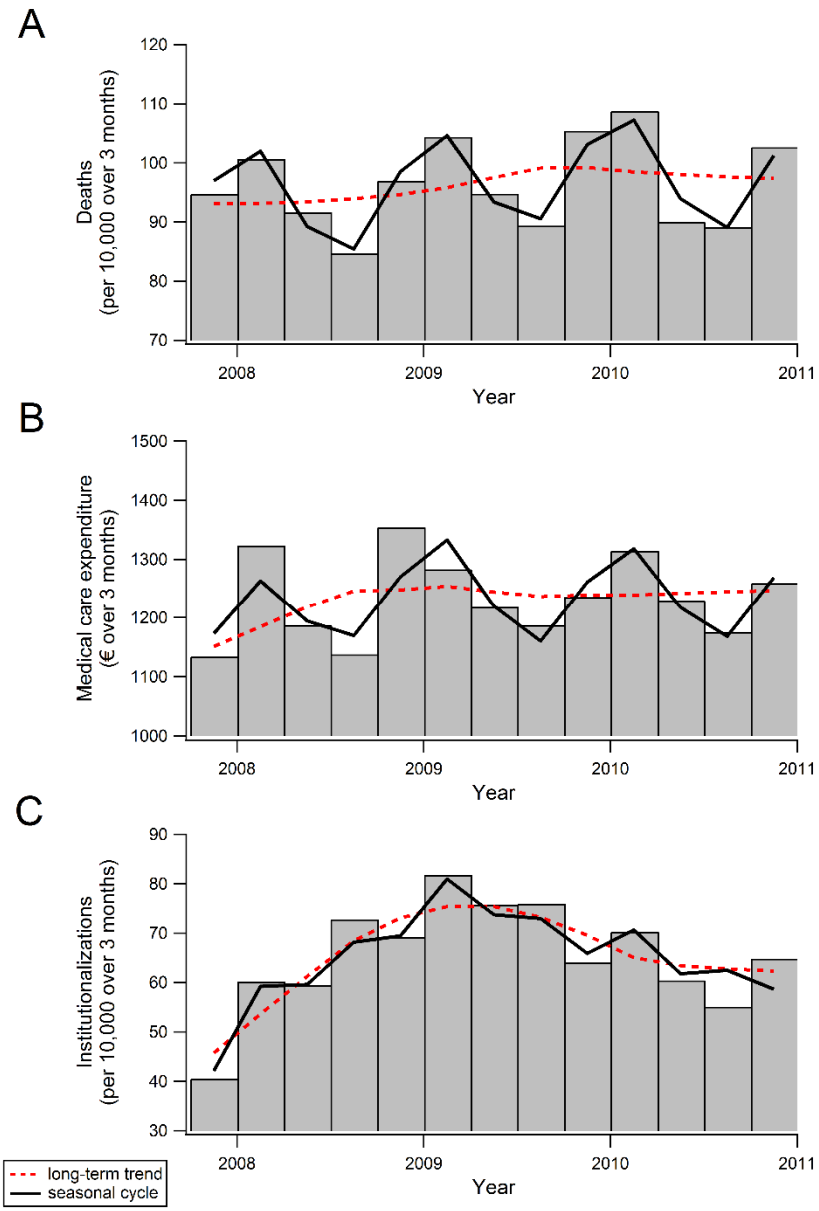

Figure 1. The number of deaths (panel A), level of medical care expenditure (B) and number of institutionalizations (C) in a cohort of Dutch older people. The raw data are decomposed into a long-term trend (dotted line), and the seasonal variation, or 'cycle', around the long-term trend (solid line). Results are from the Seasonal and Trend decomposition using Loess (STL) method.

Figure 2 shows the seasonal variation for mortality rates (panel A), MCE (panel B), and institutionalization rates (panel C). The figure expresses the absolute difference from the long-term average. The average of all years and seasons is set at zero with the corresponding confidence interval as a coloured band. When the point estimate of the seasonal component is outside this confidence interval, it is significantly different from the long-term trend. Visible from figure 2 is that all seasonal means differ significantly from the long-term trend for mortality and MCE. Institutionalization rates only differ significantly from the long-term average during the winter period.

The average number of deaths (fig 2, panel A) in every season (all three months) was 96 per 10,000 persons from July 2007 through 2010 according to the long-term trend. On average, there are 9 more deaths per 10,000 population in all three months of the winter period (+9%). Similarly, per 10,000 population there are 4 less deaths in the spring (–4%), 9 less in the summer (–9%), and 4 more in the autumn (+4%). Therefore, the average number of deaths per 10,000 population was 87 in the summer and 105 in the winter. Relatively, the number of deaths in older people is thus 21% higher in the winter than in the summer.

Panel B of figure 2 shows that MCE is also higher in the autumn and winter than in the spring and summer. Average MCE per person was €1,231 per season (all three months) in the studied time period (based on the long-term trend). Expenditure per person was €79 above this average in the winter (+6%), €24 lower in the spring (–2%), €76 lower in the summer (–6%), and €23 higher in the autumn (+2%). Consequently, seasonal MCE rises with 13% from the summer to the winter (€1,155 vs. €1,310 per person).

The average number of institutionalizations was 65 per 10,000 persons in the study period. Only the institutionalization rate in the winter differs significantly from the long-term trend, when, on average, 6 more older people are institutionalized per 10,000 population. Consequently, there is a rise of 9% in institutionalizations in the winter compared the long-term average, and, since the institutionalization rate in the summer equals the long-term average, it is also 9% higher when comparing the winter to the summer (71 vs. 65 per 10,000 persons). The autumn is characterized by the lowest number of institutionalizations.

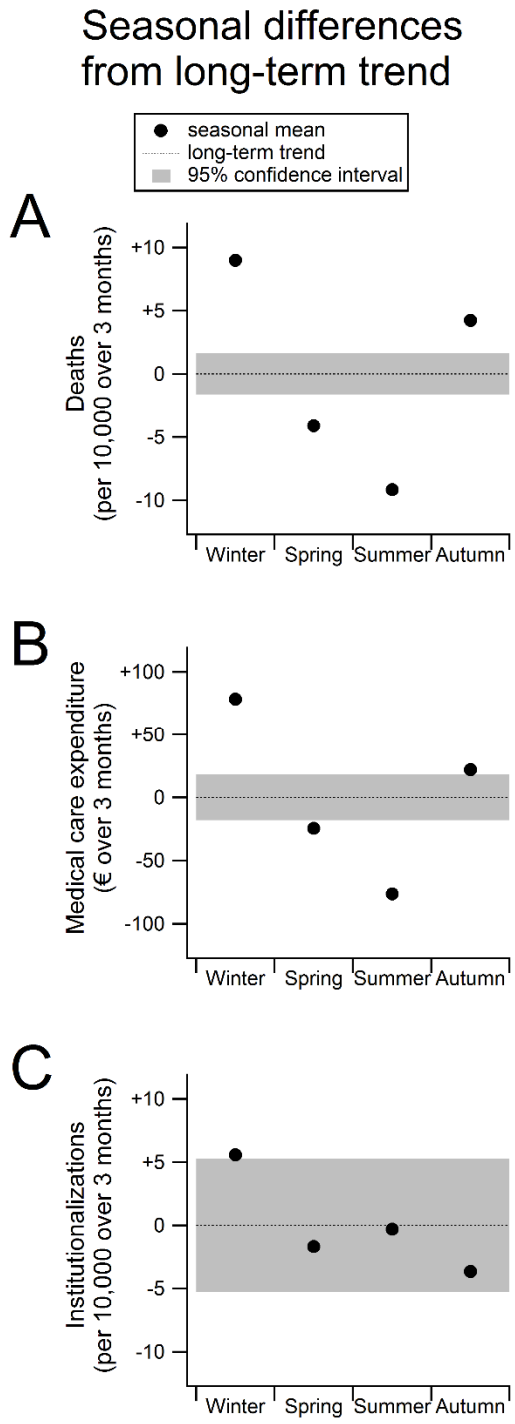

Figure 2. Seasonal variation in mortality (A), medical care expenditure (B) and institutionalizations (C). Shown are the long-term trend and seasonal cycles around the long-term trend according to the Seasonal and Trend decomposition using Loess (STL) method. The dotted line represents the long-term trend, which is set to 0. The grey band around 0 expresses the 95% confidence interval of the long-term trend. The four point estimates in each panel form the mean difference from the long-term trend for each season. When the point estimate of the seasonal component is outside this confidence interval, it is significantly different from the long-term trend.

In table 2, the specific data are shown for the mortality rates, MCE, and institutionalization rates for the total study population (described above), as well as for subgroups based on gender, age, residential status and vital status. Visible in table 2 is that for both the deceased and non-deceased subgroup, MCE is higher in the autumn and winter and lower in the spring and summer. Average MCE was €1,022 per season for individuals surviving, and expenditure was €62 above this average in the winter (+6%), €14 lower in the spring (–1%), €69 lower in the summer (–7%), and €20 higher in the autumn (+2%). Consequently, MCE for the non-deceased group is 14% higher in the winter than in the summer (€1,084 vs. €953). In contrast to all the other subgroups, the lowest level of MCE in the deceased group is not reached in the summer, but in the spring. Seasonal variation is less pronounced in the deceased group: MCE is 6% lower in the summer than in the winter for individuals in their last year before death (€4,385 vs. €4,137), and 7% lower in the spring (€4,385 vs. €4,102).

There is greater seasonal variation in the mortality of men than that of women: the male mortality rate is 26% higher in the winter than in the summer, and this difference is 16% for women. In contrast, seasonal changes in MCE are more prevalent for women than for men: MCE is 16% higher in the winter than in the summer for women, and this difference is 10% for men. There is not much difference between the two age groups concerning seasonal variation in mortality rates, MCE and institutionalization rates. However, seasonal variations are slightly more concentrated in a winter peak for the older patients, and more dispersed throughout the seasons for younger patients.

There is seasonal variation in mortality rates for both community-dwelling and institutionalized subjects. For community-dwellers mortality rates differ significantly from the long-term trend in all the seasons. The average number of deaths per 10,000 persons was 67 in the summer and 81 in the winter, meaning the number of deaths are 21% higher in the winter compared to the summer. With 27%, this difference between the winter and summer is higher for those who were institutionalized. For them, mortality rates differ significantly from the long-term trend in the winter and summer only.

Table 2. Seasonal variation in mortality rates, medical care expenditure and institutionalization rate of an older population (n=61,495), divided into different subgroups, in the Netherlands from July 2007 through 2010.

	Deaths (per 10,000 over 3 months)					**Medical care expenditure (€ over 3 months)**					**Institutionalizations (per 10,000 over 3 months)**				
	Yearly average	*Difference from the long-term trend*				*Yearly average*	*Difference from the long-term trend*				*Yearly average*	*Difference from the long-term trend*			
		Winter	Spring	Summer	Autumn		Winter	Spring	Summer	Autumn		Winter	Spring	Summer	Autumn
All subjects	96	**+9**	**−4**	**−9**	**+4**	1,231	**+79**	**−24**	**−76**	**+22**	65	**+6**	−2	0	−4
Gender															
Male	117	**+15**	**−10**	**−12**	**+7**	1,328	**+59**	−9	**−72**	**+22**	46	**+5**	**−5**	+1	−1
Female	82	**+5**	0	**−7**	**+3**	1,167	**+91**	**−34**	**−79**	+21	78	+6	+1	-1	−5
Age															
65-79[a]	55	**+5**	**−3**	**−6**	**+4**	1,157	**+68**	**−20**	**−79**	**+31**	26	**+2**	0	0	**−2**
80+	215	**+21**	**−7**	**−17**	+4	1,446	**+109**	**−36**	**−68**	−5	179	**+15**	−6	−1	−8
Deceased															
No	--- N/A ---					1,022	**+62**	−14	**−69**	+20	--- N/A ---				
Yes, <1 year[b]						4,235	**+150**	**−133**	**−98**	**+80**					
Residential status															
Community	74	**+7**	**−3**	−7	**+3**	--- N/A ---					--- N/A ---				
Institutionalized	798	**+93**	−36	**−94**	+37										

Bold figures are significantly different from the long-term trend at p<0.05. N/A = Not applicable, or not of interest.

[a] Here, the number of subjects per age group is defined at baseline; subjects can move from the 65-79 to the 80+ group during follow-up.

[b] The number of deceased in this table differs from that in table 1, because table 1 included only those who died during follow-up, and this table included all subjects who died during follow-up or within one year after follow-up.

Institutionalization rates are consistently lowest in the autumn and highest in the winter, regardless of which subgroup is considered. The size of the relative differences between the autumn and the winter are also similar across subgroups: the lowest difference is 13%, found in males and those aged 80 years and older, while the highest difference is 17%, found in those aged younger than 80 years

Discussion

We find that older people die more in the winter and autumn than in the spring and summer. Furthermore, their average level of MCE is considerably higher in the winter than in the spring and summer, and their risk of institutionalization peaks in the winter. Seasonal variation is stronger for men than women, but rather similar between age groups, deceased and non-deceased subjects, and institutionalized and community-dwelling elderly.

Interpretation of results

Previous studies already showed that mortality in the older population is associated with the seasons,[1-16] but seasonal variation in MCE is a novel finding. The changes in mortality, MCE and institutionalization suggest that older people's health is affected by the seasons. It has been found that health is affected by harsh climate conditions, such as cold temperatures,[1,2,4,7-10,12,13,15,16] and heat waves.[2,3,6,7,9,11-13] In contrast to some of these studies, we did not find increased mortality rates during the summer. Higher mortality rates in the summer are related to extremely hot temperatures, mainly during heat waves. Extreme hot temperatures are not common in the Netherlands, and, when they occur, usually last only several days.

Different biological pathways could underlie the influence of ambient temperature on older peoples' health. For example, it has been found that colder temperatures are associated with increased blood pressure,[29,30] higher blood-clotting activity,[31] and decreased lung function in COPD patients.[32] In contrast, very warm temperatures can also cause physical problems. For example, the thermoregulatory function and heart rate variability of older people decrease during extremely warm days.[33,34] We could not measure whether temperature had a strong influence on mortality, MCE and institutionalization as the time frame of our study is too short for this purpose. Also, the data points in our data represent months and quarter years, not days, making the data too crude to investigate this properly. The finding that the mortality rates of institutionalized elderly changes with the seasons suggests that outside temperature may not even

play a major role in the seasonal variations found in this study, as the institutionalized elderly are subjected to relatively constant inside temperatures.

Besides ambient temperature, there are many different season-dependent factors that potentially affect population health. First, it is possible that flu underlies seasonal variation in mortality and MCE, as prevalence rates of flu are higher in the winter, and institutionalized people are also – or even more – susceptible to flu compared to those in the community setting.[35] Second, snow and ice may increase the risk of falls and resulting fractures, especially in older people in the community setting.[26] Third, studies have shown that sunlight has a positive effect on health, such as pain after spinal surgery,[36] and length of stay and survival after myocardial infarction.[37] Fourth, the level of air pollution shows an association with seasonal changes, and air pollution has an important impact on health outcomes, such as mortality,[38] stroke,[39] diabetes,[40] mental health,[41,42] and even atherosclerosis.[43] Fifth, there is evidence that atmospheric pressure and humidity also affect population health.[44,45] Sixth, and finally, it is possible that the demand and supply of outpatient care is lower during the summer due to the summer holidays of clinicians and patients, also leading to lower expenditure levels in this season. However, if this would be a major cause of the found seasonal variation in MCE, it would be more plausible that MCE is highest in the autumn, and not in the winter, because outpatient care would peak after the summer holidays.

A higher prevalence of flu in the winter, as well as reduced hours of sunlight, may explain why older people in residential care also show seasonal variation in their mortality rates. Our analysis shows that men suffer more from seasonal changes than women, which stands in contrast to other findings.[3,8,15] It is unclear why our results differ from these previous findings, but it is possible that our study population shows discrepancies with those used in previous studies.

There are different explanations for the winter peak in institutionalizations. First, it is possible that climate conditions drive up the demand for long-term care. In this case, an exacerbation of chronic illnesses in the winter could stimulate elderly patients or their family to choose for more intensive long-term care. Second, it is possible that higher mortality rates in the winter drive up the supply of long-term care. In other words, a higher number of deaths results in a higher number of vacancies, and, consequently, a higher rate of institutionalizations if care and nursing homes are functioning at full capacity. Third, although small changes in long-term care policy took place from July 2007 through 2010 – some specific types of home care were abolished – it is implausible that these changes caused a peak in institutionalizations in the beginning of each year.

Strengths and weaknesses

The existence of seasonal variation in MCE, both close to death as well as independent from impending death, and institutionalization is a novel finding. For the purpose of our analysis, we were able to analyse data on a large study population, which could be separated into several subpopulations, and we used an advanced statistical method to disentangle seasonal variation from a long-term trend and other variation. However, the time period over which we could perform our analysis was rather short (three and a half years). Because, in addition, the data pertained to monthly or quarterly averages, we could not assess the proportional impact of flu, snow and ice, air pollution, sunlight, ambient temperatures, or other climate conditions on mortality, MCE and institutionalization. Another issue pertains to the representativeness of the study population. The study population consists of clients from one health insurer within specific regions of the Netherlands. Although the study population is quite comparable to the Dutch population aged 65 and older in terms of gender and marital status, the number of people aged 80 and older in the study population was relatively low (20% vs. 26.5%).[46] We could not ascertain how representative our study population was in terms of other characteristics.

Implications and future research

We performed this study for three reasons: (1) to make policy-makers aware of the impact the seasons can have on the health of older people (if any), as well as the collective health care budget; (2) to show epidemiologists and health economists if and how much the seasons affect MCE and institutionalization rates; and (3) to find out if specific patients groups are more at risk during certain seasons – in this case policy-makers and clinicians will know which patient groups will most likely benefit from targeted interventions.

If the findings from our analysis of the older population in this region of the Netherlands are translated to the entire older Dutch population in 2012 – with a size of ±2.7 million – they would imply that there were 6,880 more deaths amongst older people in the Netherlands in the autumn and winter than in the spring and summer [46]. In addition, MCE of older people were 630 million Euros higher in the cold than the warm seasons in 2012. For epidemiologists and health economists, it is imperative to acknowledge the possible existence of seasonal variation in their data, and include variables representing seasonal variation when performing longitudinal or time series analyses. Policy-makers and health care insurers should be aware of the seasonal differences in MCE and institutionalization to be able to effectively allocate resources in the budgets under their control.

Furthermore, seasonal variation in mortality rates and medical care expenditure could warrant policy changes that could benefit older people and/or decrease the expenditure levels. The finding that institutionalized elderly have a more pronounced seasonal variation in mortality, show that these people may benefit from programmes targeting health care workers' vaccination or hygiene, improving sunlight exposure or vitamin D status, or promoting better climate control in residential care facilities. To prevent increased levels of MCE or deaths of community-dwellers in the colder seasons, it is of primary importance that we understand which climate conditions impact their health, and through which biological pathways.

Further investigations into seasonal changes in health, MCE and mortality should preferably use daily data over a long period in time, and include many different variables, such as ambient temperature, flu prevalence, sunlight hours, air pollution, atmospheric pressure, and humidity. Furthermore, including data on the types of illness or causes of death could disclose which biological pathways are mainly associated with seasonal changes in health and expenditure.

Conclusions

Seasonal changes affect the mortality risk and level of medical care expenditure of older people; both outcomes are highest in the winter and lowest in the summer. Institutionalization rates peak in the winter. Seasonal variation is stronger for men than women, but similar between age groups. Changes in outside temperature cannot solely explain the seasonal variation in mortality because seasonal variation in mortality is similar for institutionalized and community-dwelling elderly. Also, seasonal variation in mortality cannot solely explain the variation in medical care expenditure, because the seasonal variation in medical care expenditure is present in the deceased and non-deceased population. Policy-makers, epidemiologists and health economists are urged to acknowledge and include the impact of the seasons in future policy and research. In a time where many countries are faced with population ageing, it is imperative that we gain insight into the causes of seasonal-dependent health deterioration as well as the best clinical means and policy measures to improve the health of older people.

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Chapter 4

The association between expenses for general practice and other health care expenses later in time

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Abstract

Background: An effective primary care system holds potential to curb health care expenditure (HCE), as general practitioners (GPs) provide services that prevent utilization of other, often more costly health care services. However, there is insufficient evidence to support this claim. We aim to investigate whether HCE of older people decline when they make more use of GP services.

Methods: Data on medical care expenses and long-term care utilization from clients aged 65 and older were retrieved from a regional health care insurer and linked to data on long-term care fees from the Health Insurance Board, socio-economic status from the Netherlands Institute for Social Research, and other socio-demographic characteristics from Statistics Netherlands (n=16,433). The association between GP expenditure (first 18 months of follow-up) and expenses for other health services later in time (from 19th month onward) was analysed with generalized linear models and two-part models with standardization for mortality, baseline expenses for other health care services, socio-demographic characteristics and time variables.

Results: For every €10/month of GP expenditure, the expenses for other health care services later in time increase with €74/month (p<.001). Specifically, expenses increase with €27/month for hospital care (p<.001), €17/month for medical care expenditure other than GP and hospital care (mainly medication, physio- and psychotherapy, and instrumental aids), and €33/month for long-term care.

Conclusions: We found a positive association between GP expenditure and expenses for other health care services later in time in a cohort of Dutch older health insurance clients. The positive association can be explained by three dynamics: (1) expenses for GPs are automatically associated with expenses for other health care services because patients often receive or even require a referral from the GP before receiving specialist health care; (2) GPs could increase the overall level of HCE by improper diagnoses or unnecessary referrals; (3) our statistical methods did not adequately account for the likelihood that patients who have more health problems visit GPs *and* other health care providers more frequently.

Introduction

A strong primary care system is proposed as a policy-instrument for the many countries facing important challenges to their health care system, such as a higher share of older people, increasing life expectancy, rising levels of national health spending, growing inequity, and commercialization.[1,2] This beneficial effect is mainly based on the assumption that the general practitioner (GP) can serve as an effective gatekeeper. The GP acts as a coordinator of care, scrutinizing whether specialist treatment is necessary. If not, the patient can be reassured or a period of watchful waiting can commence. If specialist care is necessary, the GP can point out which specialist or health practice is best suited for provision. Another benefit is that GPs can offer basic treatments at low costs, without the need for further specialist visits, and are less inclined than specialists and therapists to engage in costly diagnostics or treatments. All in all, this implies that a strong position for the GP holds potential to reduce spending levels on health care. However, there are also reasons to believe a strong position for the GP could increase health care expenditure (HCE). If a disease that warrants specialist attention – such as cancer – is not diagnosed properly, a patient might not receive the necessary follow-up treatment, leading to a exacerbation of HCE later in life, or even fatality.[3,4] On the other hand, GPs can also be responsible for inappropriate or unnecessary referrals, again leading to increased HCE.[5,6]

Research on the net effect of a strong position for GPs on HCE is scant and contradictory. In two longitudinal analyses of health care costs in OECD countries, countries with a gatekeeping system were found to have slower growth in expenditure in some periods of time,[7] or for ambulatory care only.[8] A study performed in the US shows that health care utilization rates are lower in areas with relatively more GPs.[9] Results from other studies suggest that strong primary care systems increase public health and decrease avoidable hospitalizations, but at the cost of higher levels of national health spending.[10,11] In the Netherlands, frequent attenders to GPs (10% of GP visitors with the most visits) are found to have higher medical care expenses (MCE) when adjusting for possible confounding factors.[12] A systematic review of literature on national gatekeeping programmes yielded a small set of studies that incorporated HCE, which were found to be of poor quality.[13]

In this study, we aim to estimate how the expenses for GP services relate to expenses for health care services later in time. A database on 16,433 Dutch health insurance clients aged 65 and older from July 2007 through 2010 was at our disposal to analyse this association. We hypothesize that GP expenditure is inversely associated with expenses for other health care services later in time in a population of older people,

when adjusting for baseline expenses for other health care services, socio-demographic characteristics, and time variables. Understanding the effect of the gatekeeping role of the GP on HCE is important in a time where policy-makers are urged to curtail ever rising levels of health care spending.

Methods

Data sources

With the aim to perform multiple studies on the association between the life situation of older people and their health care expenditure (HCE), the Leiden Health care Costs in Old Age (LHCOA) study was started in 2011. For this study, data on HCE of clients aged 65 and older in a period of 42 months were retrieved from a regional Dutch health care insurer (*Zorg & Zekerheid*) and matched with data on socio-economic characteristics from Statistics Netherlands (*Centraal Bureau van de Statistiek*). Data were collected in the following steps:

1. After consulting the IRB (legal department) of the regional health care insurer, data on medical care expenditure (MCE) were retrieved from the health care insurer's management information system. Data were collected for the period July 2007 through 2010 for all persons who lived in the regions where the health care insurer acted as the long-term care office, and who reached the age of 65 before 2011. Addresses were linked with data on socio-economic status by postal code, provided by the Netherlands Institute for Social Research.
2. In accordance with the IRB of the health care insurer, data on long-term care utilization were collected from the EMEA Care Registration system (ECR), an information system which offers an oversight of all the coded messages that are sent between organizations active within the confounds of the EMEA. ECR messages designating the start and end of long-term care provision were linked with national average fees per volume unit, provided by the Health Insurance Board. The received volume of extramural treatment were unknown, and no expenses could be calculated for this service type.
3. After consulting the IRB of Statistics Netherlands a single transfer of data from the health care insurer to Statistics Netherlands was done over a secure line. CBS staff merged the data using citizen service numbers and dismissed any personal data afterwards. The authors could then only access the de-identified data in a secured

room of Statistics Netherlands. The authors had no access to identifying information. Any output destined for publication was first scrutinized by the IRB of Statistics Netherlands, so no output could be traced back to individuals.

Study design

The aim of this study was to investigate the effect of GP expenditure on expenses for other health care services later in time (oHCE). To capture a causal effect rather than just an association, we set up our study such that the outcome variable (oHCE) applied to a time period following that of the main determinant (GP expenditure). The mean follow-up per individual in the total study population (n=61,495) was ±36 months. GP expenditure was calculated over the first half (18 months) of follow-up. oHCE was defined as the mean monthly HCE – except for GP services – after the first 18 months. The database should therefore consist of subjects with at least 19 consecutive months of follow-up (n=16,433).

Statistical analyses

It is plausible that a positive correlation between GP expenditure and oHCE is found when morbidity is not adequately adjusted for: patients with higher morbidity simply require more services, and will therefore have higher expenses with regard to all services. However, because the health care insurer could not provide us with data on specific diagnosis codes of individuals due to privacy concerns, information on morbidity could not be acquired. Instead, we used 'baseline health care consumption' as a continuous variable in our regressions models to adjust for confounding by morbidity. Baseline health care consumption equals the monthly average of total expenses for all health care services except for GP care in the first 18 months of follow-up. A log scale was applied because of a lack of normal distribution. Log transformation resulted in a score ranging from 0 to 10 with a normal distribution.

Besides baseline health care consumption, we included mortality (as a dummy variable), age, gender, marital status, socio-economic status, and calendar time as determinants in our analysis. To measure the association between GP expenditure and oHCE, while adjusting for these other determinants, we used a generalized linear model (GLM) – either stand-alone or in a two-part model. A GLM had to be used to account for the skewed nature of the outcome variable. Two-part models needed to be used as a relatively large share of patients did not incur any expenses for some health care services. We also applied these models to separate forms of HCE, like expenditure for hospital care, or home care. The consequence of using two different models in our analyses

is that the model predictions of expenses for different health care services could possibly not completely add up to the prediction of oHCE.

Health care services with a high share of zero expenses in the total study population were hospital care (16.2%), home care (80.1%), care and nursing homes (92.6%), other forms of long-term care (95.4%), and total long-term care (75.2%). Low shares of zero expenses were observed in non-hospital forms of medical care (2.3%), total medical care (1.9%), and oHCE (1.6%). We used a two-part model with logit model in the first part of the model, and a GLM with gamma distribution and log link in the second part.[14,15]

Results

Table 1 shows the characteristics of the study population. In this study, because of our selection age, there are more women than men (61% vs. 39%). Overall, the subjects have a relatively high socio-economic status: 70% of the study population lives in an a postal area where the average socio-economic status is above the median.

Table 1. Characteristics of the study population (n=16,433).

	n (%)
Gender	
Men – No. (%)	6,346 (39)
Women	10,087 (61)
Age	
65-79	12,228 (74)
80+	4,205 (26)
Marital status	
Married	8,416 (51)
Divorced	1,748 (11)
Widowed	5,316 (32)
Never married	953 (6)
Socio-economic status	
Lower	4,850 (30)
Higher	11,583 (70)
Deceased during follow-up	1,354 (8)

Table 2 shows the association of GP expenditure, socio-demographic variables, time variables, mortality, and baseline health care consumption with oHCE.

Table 2. The association between GP expenditure and total other health care expenses later in time, corrected for socio-demographic characteristics, time variables, and baseline health care consumption. Results are from a multivariate generalized linear model.

	Expenditure for all health care services other than GP, later in time (=oHCE)[1]		
	€/month	95% CI	p
GP expenditure[2]			
Per €10/month	+74	+48 to +100	<.001
Baseline health care consumption[2]			
Per level (ascending, total of 10)	+301	+278 to +323	<.001
Gender			
Male	*Ref*		
Female	−58	−113 to −4	.037
Age			
65-79	*Ref*		
80+	+364	−294 to +433	<.001
Marital status			
Married	*Ref*		
Divorced	+143	+60 to +225	.001
Widowed	+149	+86 to +212	<.001
Never married	+366	+257 to +374	<.001
Socio-economic status			
Lower	*Ref*		
Higher	−97	−154 to −40	.001
Calendar year			
2009	*Ref*		
2010	−4	−6 to −2	<.001
Seasons			
Spring and summer	*Ref*		
Autumn and winter	+1	−2 to +4	.380
Mortality			
Survived	*Ref*		
Deceased	+1,091	+880 to +1,303	<.001

[1] Applies to the 19th month of follow-up and after.

[2] Applies to the first 18 months of follow-up.

There is a significant association between GP expenditure and oHCE: for every €10/month of GP expenditure, there is a €74/month increase in oHCE (p<.001). Baseline health care consumption also has a significant impact on oHCE, with €301/month for every level of health care consumption on a 10-point scale (p<.001). Overall, oHCE of women is lower than that of men (−€58/month; p=.037). oHCE of the older age group (aged 80 years and older) is €364/month higher than their younger counterparts (aged from 65 through 80 years).

Subjects that are not or no longer married have higher oHCE than married subjects: this is +€143/month for those divorced (p=.001), +€149/month for those widowed (p<.001), and +€366/month for those never married (p<.001). Subjects with a higher socio-economic status have a lower level of oHCE (−€97/month; p=.001). If a subject dies during the second period of follow-up, his or her oHCE are €1,091/month higher than if he or she survives (p<.001). Calendar year has a very low but significant impact on oHCE (−€4/month lower in 2010 compared to 2009). Seasonal changes did not have a significant impact on health care expenses in this analysis.

Table 3 shows a further specification of the associations between GP expenditure and expenses for different other health service types later in time, standardized for socio-demographic variables, time variables, mortality and baseline health care consumption. There is a significant association between GP expenditure and expenses for all other different health services later in time, and all associations are positive.

Table 3. The association between GP expenditure and monthly expenses for other health care services later in time.

Service type	*€/month*	*95% CI*	*p*
All health care services other than GP	**+74**	**+48 to +100**	**<.001**
Medical care	**+37**	**+23 to +51**	**<.001**
Hospital	+27	+18 to +36	<.001
Other medical care	+17	+10 to +24	<.001
Long-term care	**+33**	**+25 to +42**	**<.001**
Home care	+20	+15 to +25	<.001
Care/ nursing home	+15	+10 to +20	<.001
Other long-term care	+7	+4 to +10	<.001

Shown is the change in health care expenses per month after the 18th month of follow-up for every €10/month of GP expenditure in the first 18 months of follow-up, standardized for baseline health care consumption, mortality, socio-demographic characteristics, and time variables.

For every €10/month of GP expenditure, medical care expenses later in time are €37/month higher (p<.001), and long-term care expenses are €33/month higher (p<.001). When GP expenditure increases with €10/month, hospital expenses later in time increase with €27/month (p<.001). Expenses for other medical care services – such as medication, physiotherapy, and instrumental aids – increase with €17/month (p<.001). There is an increase in expenses for home care with €20/month (p<.001), for care and nursing homes with €15/month (p<.001), and for other long-term care services with €7/month (p<.001).

Discussion

We found that older people who have higher expenses for services from general practitioners (GPs), in turn also have higher health care expenditure (HCE) for other health services later in time. All in all, for every ten euro spent on GP care, expenditure for other health care services later in time is €74 higher. The positive association can be explained by three dynamics. First, expenses for GPs are automatically associated with expenses for other health care services because patients often receive or even require a referral from the GP before receiving specialist health care. Second, GPs could increase the overall level of HCE by improper diagnoses or unnecessary referrals.[3-6] However, we could not distinguish between necessary vs. unnecessary referrals, or improper vs. proper diagnoses. Third, the positive association may reflect health care 'patterns' in the population of older patients. In other words, it is possible that patients who visit GPs more often, have more health problems than those who visits GPs less frequent, and that these patients have higher expenses for GPs and the bulk of other health care services.

The hypothesis we set out in the introduction – that GP expenditure is inversely associated with expenses for other health care services later in time in a population of older people, when adjusting for baseline health care consumption, socio-demographic characteristics, and time variables – was not corroborated by the results of our analysis. We reasoned that through selective referral to specialists, restricted use of costly diagnostics,[16] watchful waiting,[17] and the ability to provide basic medical services at lower expenses, the GP improves efficiency and allocation of hospital care. If such an effect is present, it is possible that we could not discern it because we lacked specific data, mainly in terms of morbidity.

Patients with a higher level of morbidity will make use both the GP and other health care services more often than those with a lower level of morbidity. If morbidity

is not adequately adjusted for, it is a logical consequence that one will found a positive correlation between GP expenses and HCE for other services. In our analysis, we tried to adjust for morbidity by including baseline health care consumption and the risk of mortality in our analyses: both determinants will most likely rise when a subject's morbidity level is higher. Another reason to include mortality was the considerable impact of proximity to death on health care expenses.[15,18-20] It cannot be ruled out that more specific data is needed to adequately account for morbidity, such as disease-specific diagnoses and severity of the diseases. Because the health care insurer could not provide us with data on specific diagnosis codes of individuals due to privacy concerns, such information on morbidity could not be acquired.

The finding that married subjects and those with a higher socio-economic status have lower health care expenses than single subjects and subjects with a lower socio-economic status confirms findings in other studies incorporating these determinants.[21-28] Calendar year was included as a determinant as this reflects the influence of changes in policy and health care prices, as well as general inflation.

As our investigation could not ascertain a cause-and-effect association between the use of GP services and HCE for other services, further research is needed to answer the question whether GPs can curtail HCE. Specifically, more studies are needed that effectively account for morbidity. Further research is imperative, as the stability of many health systems are threatened by financial, demographic and cultural challenges, such as rising pressure on public finances, growing shares of older people, and increasing patient demandingness. It has been suggested that the GP could play a pivotal role in facing these challenges, however we were not able to substantiate this in this study.

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Part II

Determinants on the micro-level:
Patient-centred care, the spouse and time to death

Chapter 5

The development, implementation and evaluation of a transitional care program to improve outcomes of frail older patients after hospitalization

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Abstract

Background: A fragmented healthcare system appears badly suited to treat the increasing number of older patients with multi-morbidity and complex care needs. Here we report on the development, implementation and evaluation of a regional transitional care programme aimed at improving outcomes of frail hospitalized older patients with complex care needs.

Methods: The programme was drafted in co-creation with organizations representing older adults, care providers, and knowledge institutes. In a pre-post evaluation study, the incidence of adverse outcomes within three months after hospital admission, and long-term care expenses (LTCE) were compared. Patients aged ≥70 years, electively or acutely hospitalized in four hospitals in the targeted region, were included in the sample in 2010-2011 (pre) and 2012-2013 (post).

Results: Developed innovations addressed (1) improved risk management;(2) delivery of integrated, multidisciplinary, function-oriented care; (3) specific geriatric interventions; (4) optimization of transfers between centres. 891 and 1042 patients were included in the two cohorts, follow-up data were available for 813 and 904 patients. The incidence of adverse outcomes in frail patients decreased from 49.2% (149/303) in cohort 2010-2011 to 35.5% (130/366) in cohort 2012-2013. The risk ratio (RR), adjusted for heterogeneity between hospitals, was 0.72 (95%CI:0.60-0.87). In non-frail patients the incidence of adverse outcomes was unchanged (RR: 1.02, 95% CI: 0.76-1.36). LTCE were similar in the two evaluation cohorts.

Conclusions: The incidence of adverse outcomes was significantly reduced in frail older patients after the transitional care programme was carried out. The transitional care programme involving all regional stakeholders in integrated transitional care has led to feasible and cost-effective innovations of care for frail older patients after hospitalization.

Introduction

The proportion of patients that is admitted to hospitals with multiple interacting medical conditions is increasing. This upturn is mostly caused by the fact that people, with and without diseases, live longer. The prevalence of multi-morbidity strongly increases with age and by the age of 65 years the majority of people suffer from multiple medical conditions.[1] Nowadays healthcare is primarily delivered by highly specialized but fragmented disciplines. Current healthcare organizations offer adequate provisions for patients with a single medical condition that can be treated within the context of that specialized discipline. Frail patients with multiple medical, mental, social and/or cognitive problems, have far more complex care needs and require involvement of multiple specialties and disciplines.[2] A fragmented healthcare system appears not well suited to treat older patients with multi-morbidity. The inadequacy of our current healthcare system is illustrated by the large proportion of older patients who experience loss of function and new dependency during and after hospitalization.[3-6]

In the Netherlands, the National Care for the Elderly Programme started in 2008.[7] The programme was designed to improve care for older adults with complex care needs by providing coherent integrated care that is better suited to the individual's needs. The programme acknowledged that good care for older adults crucially depends on coordination between the various stakeholders involved. The programme did not exclusively focus on medical care, but encompassed the entire range of (health) care and assistive support available for older patients with complex needs. To start the necessary innovation process, regional networks were formed in which all stakeholders involved in the care for older patients participated. It was the explicit intention that older adults themselves would participate in the design, implementation and evaluation of the reforms as this was expected to have an additional value.

As part of the National Care for the Elderly Programme, a transitional care programme was initiated in the region of Leiden. In co-creation with organizations representing older adults, a programme was drafted that aimed to improve patient-centred integrated care for frail older patients with complex care needs in transition. Joining forces at regional level, care providers, healthcare insurers and local authorities conceived innovations and committed to the integrated transitional care programme. Specific actions were taken aimed to decrease the risk of functional decline and loss of independence after hospitalization. Here we report on the development and implementation of the transitional care programme and on its effects on the recovery of frail older patients after hospitalization.

Methods

Design of the transition

As an initial phase, we organized meetings with representatives of older adults and patients, and healthcare professionals of all healthcare organizations and authorities in the region. A representative of the national patient organization led the discussion to prioritize the objectives of the programme. These discussions led to the definition of the 'Components of the transition' stated in the left column of the table 'Overview of innovations within the transitional care programme'.

Management of the transition

All organizations involved in the (health) care for older adults in the region were invited to participate in the programme. Four hospitals in the Leiden region - one academic hospital and three general hospitals - committed to make a transition. Each hospital established a committee with representatives of the target population (older adults) and of participating organizations in their area. During the programme, they assembled periodically to discuss issues concerning the quality of care of their collaborations and set targets for improvement of the quality of care (referred to as 'aims'). These committees were encouraged to propose innovations within the context of the transition addressing shortcomings in their settings and collaborations (referred to as 'specific deficiencies'). The proposed innovations had to involve cooperation between at least two (health-) care providers. For each innovation, a professional of an organization involved was assigned to be the project manager responsible to implement the approved innovations (referred to as 'actions'). From the programmes' resources, the healthcare providers involved were given budgets and support to execute the specific actions that were required.

The evaluation study

To assess whether frail older patients recovered more successfully after the transition, as compared to before the transition, we performed a pre post programme evaluation. We included two samples. In the first sample, the recovery of older patients after hospitalization was assessed in 2010-2011 before the transitional care programme started. The second sample was used to evaluate whether the transitional care programme improved the recovery rate (2012-2013).

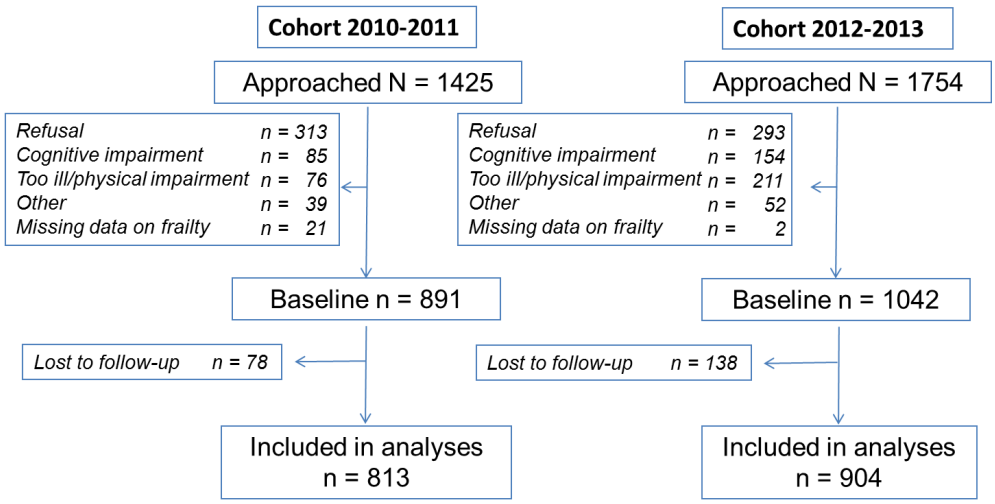

Figure 1. Flow chart of the first evaluation cohort recruited in 2010-2011 included before the transition, and a second cohort recruited in 2012-2013, included after the initiation of the transition.

Subjects

From October 1st 2010 until February 1st 2011 patients aged 70 years and over who were admitted to one of the four participating hospitals, were approached to enroll in the evaluation study. In three hospitals, both electively and acutely admitted patients in the orthopaedics, neurology, urology and general surgical departments were enrolled. In one hospital, only acutely admitted patients were approached to enroll independent of the department to which they were admitted. Patients were eligible if they stayed in the hospital for at least two consecutive days and if they were approached within 72 hours after admission. Patients with cognitive impairments (Mini Mental State Examination <19) were excluded if no informal caregiver was available to provide information. Two years later, from October 1st 2012 until February 1st 2013, a second evaluation sample was enrolled applying the same methods.

Measurements

Trained nurses interviewed the subjects enrolled. The interview consisted of questions regarding demographics and a screening for frailty using a four domain approach in-

cluding function in activities of daily living (ADL) and risk assessments for under-nutrition, falls and delirium.[8] Three months after their admission date, subjects were sent a self-administered questionnaire by mail to measure their level of functioning.

Screening for frailty

During the interview, the risk on four domains was assessed: Activities in Daily Living (ADL)-disabilities, falls, delirium and under-nutrition. ADL-functioning was assessed using the Katz index on independence in ADL, a six item instrument to assess independency.[9] Subjects were asked whether they needed help bathing, dressing, going to the toilet, transferring from bed to a chair and eating and whether they used incontinence materials (yes/no) two weeks before the interview. If two or more questions were answered positively, subjects were considered to be limited in their function. A single question on whether the patient fell in the last six months (yes/no) was used to assess the risk for falls. The risk for the development of delirium was assessed using a score based on three questions: 'Do you have problems with your memory?', 'Did you need help with self-care in the last 24 hours?', and 'Did you experience confusion during previous hospital admission or illnesses?'. If one or more of the questions was answered with 'yes', a patient was considered to have an increased risk for delirium. Nutritional status was assessed using the Short Nutritional Assessment Questionnaire (SNAQ).[10] A patient was considered to have (an increased risk for) under-nutrition when he/she either lost 6 kg of bodyweight unintentionally or lost 3 kg unintentionally and had either experienced a decreased appetite and/or used supplemental drinks or tube feeding. We obtained a score by adding up the patients' dichotomized screening results on the four subjects, resulting in a score ranging from 0-4. Patients were considered frail if aged 70 to 80 years and positive on three or four of the screened domains or when aged 80 years and over and scoring positive on one or more of the domains.[11]

Outcome

The outcomes of interest were the occurrence of an adverse outcome and the costs of long-term care three months after admittance in the hospital. Adverse outcome was defined by death or a decline of ADL function and/or a high healthcare demand. Deaths were checked in the clinical record systems of the hospital and the healthcare insurer, or were reported by family members in response to receiving the follow-up questionnaire. A decline of ADL functioning was considered present when patients reported one or more additional ADL dependencies on the self-administered Katz ADL questionnaire after three months of follow-up. The healthcare demand was assessed using data from the information system of healthcare insurer in which the start and end of long-term

care provision was registered. Patients were considered to have a high healthcare demand if they received funding for a 'care package' designating sheltered residence with intensive care. For some patients we could only obtain information regarding mortality, and they were excluded. The patients of whom we received additional information (either healthcare demand or ADL decline) were included.

The effects of the programme on costs of long-term care in the 300 days following a hospital admission were assessed. After consulting the IRB (legal department) of a regional health insurer, data on long-term care utilisation were collected from the Exceptional Medical Expenses Act (EMEA) Care Registration system (ECR), an information system which offers an oversight of all the coded messages that are sent between organisations active within the confounds of the EMEA. ECR messages designating the start and end of long-term care provision were linked with national average fees per volume unit, provided by the Health Insurance Board. The costs per volume of each service type were calculated using the average fees per volume unit in 2012 in both cohorts to adjust for the influence of inflation and other price fluctuations. The volumes of extramural treatment received were unknown, hence no costs could be calculated for this service type. There were major changes in the financial compensation of long-term care rehabilitation between 2011 and 2013, resulting in incomplete data on this service type for cohort 2012-2013. Costs for this service type were therefore also excluded from the analysis. Data were available for 300 days after hospital admission. In the analysis, both the percentage of subjects enrolled in the evaluation sample receiving care as well as the average costs of care were evaluated.

Statistical analyses

Because the transition aimed to improve outcomes in frail older patients, all analyses were separately performed in the frail and the non-frail patients. Changes in the recovery after hospitalisation over the course of the transition programme were analysed by calculating the risks for adverse outcomes in the sample included in 2012-2013 relative to the risk in the sample included in 2010-2011. To take differences between the hospitals into account weighted risk ratios were obtained performing random effect analyses using the metan function in Stata 12.0 (Stata-Corp, College Station, Texas, USA).

Ethical approval

Before the start of the study, the medical ethical committee of the Leiden University Medical Center decided that no formal ethical assessment of the protocol was necessary because the aim of the study was to evaluate the quality of care for (frail) older people. All patients received detailed written information before they were interviewed, and

could thereafter refuse to participate. Patient data were analysed and stored anonymously.

Results

Content of the transitional care programme

The four participating hospitals took on a leading role to organize and mobilize the stakeholders to improve the quality of care for older patients to prevent loss of independence following a hospital admission. Other healthcare providers, i.e. general practitioners, nursing homes, rehabilitation facilities and home care providers, soon joined the programme. During meetings led by the Federation of Patients and Consumer Organizations in the Netherlands (NPCF), older adults and healthcare professionals of all healthcare organizations in the region, prioritized the objectives of the programme. The discussion led to four main issues that all parties agreed on to need priority in the transition programme: (1) risk management; (2) delivery of integrated multidisciplinary, function oriented care; (3) specific geriatric interventions; (4) optimization of transfers between centres.

Issues concerning all healthcare organizations (of a certain type) in the region were centrally initiated in the transitional care programme. In the committees established in the hospitals, representatives of healthcare providers proposed specific innovations in the four components of the transition to tackle the deficiencies in the quality of care. The resulting programme is shown in table 1 and gives an overview of the content of the innovations targeting the four components of the transitional care programme.

The progress on the agenda of the transitional care programme was monitored on several levels. Professionals of cooperative organizations gathered in different frequencies in the committees established in each hospital. The professionals leading the implementation of the several innovations taken according to the agenda, held monthly meetings. The middle management congregated quarterly, while representatives of the board of all participating healthcare organization attended a meeting once a year.

Table 1. Overview of transitions/ interventions in the transitional care programme.

Specific deficiency	Innovation	Actions
1. Risk management: Improve the identification of frailty in hospitalized older patients in order to be able to proactively intensify geriatric care and preventive measures in patients in need.		
No systematic identification of frailty in older patients was performed in the four hospitals enrolled in the programme and proactive measures were not systematically taken. The hospitals did not have a proactively acting geriatric team.	A feasible screening instrument to identify frail older adults in an early stage of hospitalization was developed. The instrument was implemented in all four participating hospitals and follow-up interventions were designed. After a positive screening result, the need for an individualized care path is assessed.	→ A screening tool using a four domain approach (ADL function, under-nutrition, falls and delirium) was implemented. → Protocols were drafted for the follow-up of positive screening results. → Geriatric consultation teams were installed to follow-up on screening results and assess (the need for) individualized care paths.
2. Delivery of integrated, multi-disciplinary and function oriented care: Develop pathways in which care is focused on improving, preserving and/or retaining physical function and independence, and is well accommodated between disciplines and centres.		
Acutely admitted older patients are an extremely frail group of patients. Because of complex problems, often combined with cognitive disorders, the agreement between the multiple disciplines involved in care for these patients is critical. In the acute phase, not all processes were well regulated and not all professionals in the hospital had enough knowledge on how to care for frail older patients.	In one of the hospitals enrolled in the program, a systematic approach was taken to improve care for acutely admitted older patients.	→ All protocols and processes were evaluated, updated and new guidelines were constructed when needed. → Every unit appointed a nurse to be responsible to implement the protocols in his/her unit → Nursing and medical staff was educated on frailty in older patients. → Multidisciplinary meetings were held weekly, focusing on improving/preserving ADL-functioning
Older patients admitted for total knee or hip replacement need care of several disciplines and centres. Agreement between the multiple disciplines involved in the care for these patients is lacking, which increases the risk for loss of function and independence. Because the patient is the only person involved in the whole care pathway, the patients' perspective should be leading.	The multidisciplinary multicentre care pathway for patients admitted for total knee or hip replacement was redesigned based on the patients' perspective.	→ All protocols and processes were evaluated, updated and new guidelines were constructed when needed. → The agreement was improved between patient information concerning the care pathway handed-out by different healthcare providers

Table 1. Continued (1).

Specific deficiency	Innovation	Actions
2. Delivery of integrated, multi-disciplinary and function oriented care: Continued.		
No models for quality management of multicentre healthcare pathways were available. Monitoring, evaluating and improving quality of care within one healthcare organization is challenging, but when different organizations are involved in a pathway, the evaluation of the quality of the pathway gets even more complicated.	A model was developed to evaluate and improve multidisciplinary multicentre care pathways. Together, healthcare professionals involved in the CVA care pathway in the region defined and tested the model.	→ Seven substantive and measurable indicators of quality of care within the CVA care pathway were defined in agreement with all healthcare professionals → A dashboard was designed to visualize whether the indicators met the norm. → In periodical meetings, cases were discussed and bottlenecks were identified and translated into points of improvement. These points were appointed to a professional responsible to report on the progress in the next meeting.
3. Specific geriatric interventions: Improve the security of the geriatric function around the patient, by developing agreement on responsibilities in geriatric care within the various disciplines and echelons, and develop a systematic approach of assessment of the type of care frail older patients need after discharge from the hospital.		
The evaluation of the optimal destination of discharge of patients was often done at the time treatment was finished and patients were ready for discharge. If a patient was in need of follow-up care, the discharge was often delayed because arrangements were still to be made. Also, professionals reported to have difficulties with determining the optimal form of follow-up care in complex older patients.	A triage instrument was developed. Professionals of different healthcare providers together decided on the best items to include in the instrument.	→ A triage instrument to determine the best discharge destination and follow-up care for patients in an early stage of hospitalization was developed. → A website was developed on which healthcare professionals could easily use the triage instrument → The feasibility of the instrument was tested in a pilot, concluding that its use stimulated the consideration of factors influencing the needed care after discharge in an early stage. In delirious patients, timing appeared very influential and re-triage in a later stage often led to different conclusions.

Table 1. Continued (2).

Specific deficiency	Innovation	Actions
3. Specific geriatric interventions: Continued.		
No existing setting for rehabilitation was available for patients with cognitive problems that newly manifested during hospitalization. These patients frequently stayed in hospital longer than necessary, their cognitive problems worsened and their rehabilitation was harmed.	A special rehabilitation unit was opened in a nursing home for patients with a newly manifested cognitive disorder during hospitalization in order to achieve sooner discharge from the hospital to a well suiting environment.	→ A unit in a nursing home was completely refurbished to meet the needs of patients with cognitive disorders and a rehabilitation need. → Staff of the rehabilitation unit was educated to be better able to care for early discharged patients to enable patients to be transferred to the well suiting unit sooner. → The assessment of the eligibility of patients to be admitted to the rehabilitation unit was done by a geriatric nurse in close cooperation with the specialists in the hospital and nursing home. → The geriatrician from the hospital held weekly consultation visits to (the transferred patients in) the nursing home.
Older patients were frequently referred to the hospital for the analyses of falls, while the problems these patients have could often be treated by a general practitioner (GP) specialized in the care for older patients. This form of care better secures the geriatric function of patients, is more comfortable for patients and costs less.	An outpatient unit for the analyses of falls was outplaced from the hospital setting to the primary care setting.	→ In the first phase, the outpatient unit in the GPs' office was staffed by both the GP and a geriatrician from the hospital, the GP-assistant and a geriatric nurse from the hospital and physiotherapists both from the primary setting as from the hospital. → Knowledge was transferred between the disciplines and agreement was reached as for which patients should be referred to the hospital for a more comprehensive assessment. → GPs in the region were instructed which patients to refer to the outpatient unit at the specialized GP and which to the hospital.

Table 1. Continued (3).

Specific deficiency	Innovation	Actions
4. Risk management: Improve the identification of frailty in hospitalized older patients in order to be able to proactively intensify geriatric care and preventive measures in patients in need.		
When a patient was transferred from one healthcare provider to another, important information about the patient and the treatment was often lacking. It took a lot of time and effort to get a complete picture of the patient and the care and treatment needed. Lacking information hampered the rehabilitation process.	Representatives of all healthcare providers in the region cooperated to define which information each organization/ professional needs from their predecessor to optimally continue care at the time a patient is transferred. A digital system to send data to the next healthcare provider was implemented.	→ A uniform set of minimal information healthcare providers require at the time of a transfer was developed. → Based on a business case, all big healthcare providers in the region together acquired a digital transfer system to transfer the required information digitally. → Each organization appointed staff members to be responsible for the internal implementation of the digital transfer system. These professionals held meeting to discuss optimization of the system.
An effort to improve multicentre care for CVA-patients was made in the months prior to the start of the RCP. It was observed that the new protocols and procedures were not all well implemented yet. Especially, getting every professional involved to use the same methods to facilitate the rehabilitation process was challenging.	Trained nurses were hired to make an extra effort in improving the multidisciplinary multi-centre care pathway for stroke patients.	→ Expertise was shared and mutual understanding and agreement was increased through the exchange of staff between the different units of the healthcare organizations involved (hospital, nursing home, rehabilitation centre). → The trained nurses collaborated on the units to educate staff of the organizations involved to work according to the newly implemented methods to facilitate rehabilitation. They organized clinical lessons, but mostly trained staff by 'training on the job'.

Appraisal of recovery after hospitalization

To appraise the risk of loss of physical function and independency after hospitalization as well as the impact of the transitional care programme we compared two representative cohorts: a cohort of patients included from 2010 through 2011 before implementation of the programme, and a second cohort from 2012 through 2013 after implementation of the transitions.

In the two cohorts of patients, 813 and 904 patients could be included in the analyses of adverse outcomes after three months of follow-up. From 721 and 827 patients who filled out and returned the self-administered questionnaire after three months of follow-up, data on functional decline were complete. Data on healthcare demand three months after hospital admission were complete for 713 and 785 and data on mortality were complete for 816 and 916 patients, in the two cohorts respectively.

In table 2, baseline characteristics of the frail and non-frail subjects of cohort 2010-2011 and 2012-2013 are displayed separately.

Table 2. Baseline characteristics of the frail and non-frail subjects of the evaluation samples.

	Frail		Non-frail	
	Cohort 2010-2011	Cohort 2012-2013	Cohort 2010-2011	Cohort 2012-2013
Number	339	432	552	610
Sex (% male)	39.2	42.8	51.1	51.3
Age (median (IQR))	83 (7)	83 (7)	74 (6)	74 (5)
Hospital				
I	31.9	21.1	27.4	19.7
II	18.6	22.2	8.7	12.1
III	29.2	41.0	46.4	44.3
IV	20.4	15.7	17.6	23.9
Acute admissions (%)	61.9	62.0	32.0	35.0
ADL limitations prior to admission (% ≥2)[a]	36.9	29.5	3.3	3.9
Falls in last 6 months (%)	63.1	59.4	23.2	20.2
Risk for delirium (%)[b]	85.3	87.5	35.7	55.6
Risk for malnutrition (%)[c]	46.3	43.1	15.4	16.2
Specialty (%)				
Orthopaedics	22.8	24.1	30.6	33.0
Surgery	41.5	34.7	33.6	32.1
Neurology	16.9	16.0	12.0	12.1
Urology	12.2	8.1	18.2	13.1
Other	6.6	17.1	5.3	9.7

[a] ADL = Activities of daily living. ADL limitations: Katz index on independence (range 0-6).

[b] Risk for delirium: VMS Delirium (range 0-3), an increased risk was present if scored ≥1.

[c] Risk for malnutrition: VMS malnutrition (lost weight and/or both less appetite as well as energy supplement use).

In the cohorts, the prevalence of frailty was 38.0% and 41.6%, respectively. Within the strata of frailty, most characteristics were well comparable between the cohorts. Of the frail patients in cohort 2010-2011, 49.2% suffered an adverse outcome, in the 2012-

2013 cohort that percentage decreased to 35.5%. In the non-frail subjects the percentage of adverse outcomes was similar in both cohorts (14.9% and 14.7% respectively).

Figure 2 shows the lower risk for adverse outcomes in frail patients admitted to hospital in the period 2012-2013 as compared to period 2010-2011. The overall weighted estimated relative risk of all frail patients in the cohort 2012-2013 was 0.72 (95% CI: 0.60-0.87). Furthermore, the figure shows that the tendency for a reduced risk for adverse outcomes was seen in all separate components of the composed outcome (death, decline of ADL function and high healthcare demand). In non-frail patients, the risk for adverse outcomes did not change in any of the hospitals (overall RR: 1.02, 95% CI: 0.76 to 1.36).

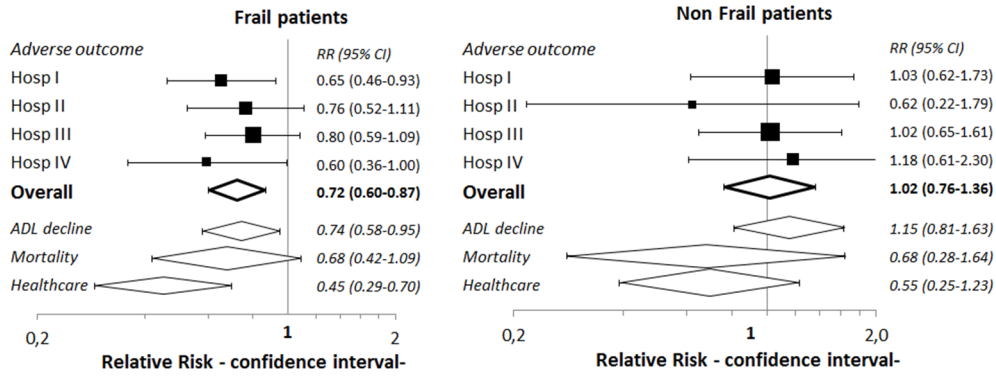

Figure 2. Relative risks for an adverse outcome in frail (left panel) and non-frail (right panel) older patients before and after the implementation of the transition care programme. Risk ratios of the four participating hospitals are presented separately. The relative risks for adverse outcome displayed with the black squares, as well as specific adverse sequelae are derived from estimated weighted, random effects analysis.

Appraisal of the effect on costs of long-term care

The percentage of the subjects enrolled in the evaluation sample that received care in the 300 days after hospital admission is shown in the left panel of figure 3. In the first 58 days after hospital admission, use of professional care was more prevalent in the sample enrolled in 2012-2013. During the rest of the follow-up period, there was no difference in care usage between the samples evident and the area under the curves was similar. The right panel of figure 3 shows the average daily costs of care of both samples in the 300 days after hospital admission. In the first six months after hospital

admission, the average costs per subject were lower in cohort 2012-2013. After six months, costs became higher in cohort 2012-2013. Overall, there was a non-significant mean difference of €0.10 per subject per day favoring the cohort 2010-2011.

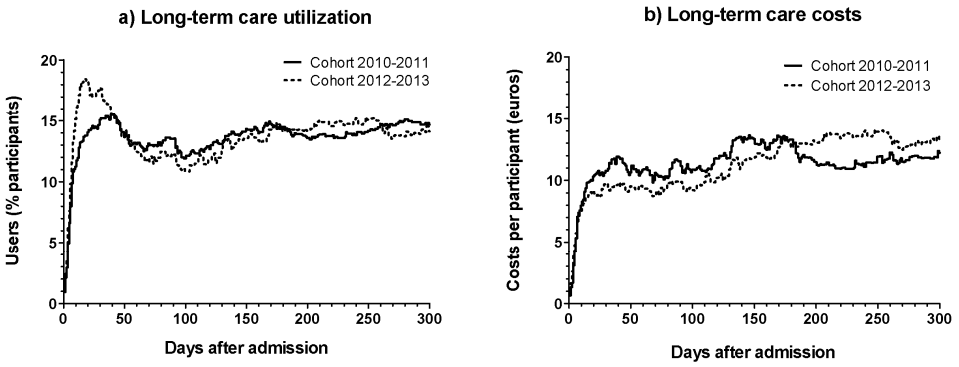

Figure 3. Number of people using long-term care after hospitalisation (a) and average costs for long-term care per person (b) for the two different evaluation cohorts.

Discussion

This pre post evaluation showed an improvement in outcomes for frail older hospitalized patients through the implementation of a transitional care programme. Within a commonly agreed framework, the various organizations involved had adapted the measures to their own organizations. It was shown that frail patients who were being hospitalized after the programme was implemented recovered more successful, while the costs of long-term healthcare remained unchanged.

Strengths and weaknesses of the evaluation study

The shared decisions between the partners as well as the continuously implemented changes in the delivery of healthcare made it impossible to conduct a randomized trial. Organizational interventions like the transitional care programme, do not allow for a timeframe sufficient to engage in such a trial, because quality improvement is a continuous process and changes in healthcare delivery occur faster than results of research are available.[12] The changes in the delivery of healthcare apply to all (older) patients to a greater or lesser extent. We do not know which patients included in the evaluation sample were treated according to which part of the programme and what measures

they benefitted from. This way, the changes in the recovery that were found in our evaluation sample represent the changes that can be expected in the whole target population of hospitalized frail older patients. By including large samples of patients from all four hospitals in the region and not applying strict exclusion criteria, we aimed to include a population representative of all frail patients targeted by the programme. However, participating in the interview might have been too burdensome for the frailest patients and they might be under represented. Because the measures taken in the programme targeted especially the frail patients, it is presumable that they would not benefit less from the measures taken than the included population. A weakness of the evaluation of the effects of the programme on costs of long-term care, is the absence of data on costs for long-term rehabilitation, which unfortunately could not be included in our economic analysis. We expect that a cost reduction due to improved recovery after hospitalization is most visible in this sector.

Comparison of the programme to previous work

A local knowledge institute took on a leading role to entice all care providers in the region to participate in the transition care programme. Collectively, the agenda of necessary actions to improve quality of care was determined by all partners. This cooperation brought about the commitment of healthcare providers and assured that the urge to improve quality of care was felt and shared by all partners. Leadership and the bottom-up design of measures, have been previously argued to be of utmost importance.[13,14] Others emphasized the importance of incorporating practices and expectations of healthcare professionals and managers in the design of measures.[9] These factors might added to the effectiveness of our programme, as the professionals were eminently involved in all initiatives. The measures proposed were adapted to fit the needs of the individual organizations. The development of tailor made measures allowed the necessary flexibility to enhance implementation in the different organizations. Making the healthcare providers themselves responsible for the implementation of the measures in their organizations and collaborations, facilitated the permanent establishment of measures. Finally, the patient centeredness of measures was enhanced by including older patients in the hospital committees.

Conclusions

Within the transitional care programme, we achieved to get commitment from the healthcare providers of different disciplines by co-creating the measures within the transition. The sustainable establishment of the innovations was enhanced by making

providers responsible to implement the measures in their care provision. Further research is desired to gain evidence on the feasibility of the measures on a wider scale.

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Chapter 6

Changes in health care expenditure after the loss of a spouse

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Changes in health care expenditure after the loss of a spouse:
Data on 6,487 older widows and widowers in the Netherlands
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Abstract

Background: In ageing populations, informal care holds great potential to limit rising health care expenditure. The majority of informal care is delivered by spouses. The loss of informal care due to the death of the spouse could therefore increase expenditure levels for formal care.

Objective: To investigate the impact of the death of the spouse on health care expenditure by older people through time. Additionally, to examine whether the impact differs between socio-demographic groups, and what health services are affected most.

Design: Longitudinal data on health care expenditure (from July 2007 through 2010) from a regional Dutch health care insurer was matched with data on marital status (2004-2011) from the Central Bureau of Statistics. Linear mixed models with log transformed health care expenditure, generalized linear models and two-part models were used to retrieve standardized levels of monthly health care expenditure of 6,487 older widowed subjects in the 42 months before and after the loss of the spouse.

Results: Mean monthly health care expenditure in married subjects was €502 in the 42 months before the death of the spouse, and expenditure levels rose by €239 (48%) in the 42 months after the death of the spouse. The increase in expenditure after the death of the spouse was highest for men (€319; 59%) and the oldest old (€553; 82%). Expenditure levels showed the highest increase for hospital and home care services (together €166).

Conclusions: The loss of the spouse is associated with an increase in health care expenditure. The relatively high rise in long-term care expenses suggests that the loss of informal care is an important determinant of this rise.

Introduction

In many developed countries, population ageing can be directly related to a rise in health care expenditure. In the Netherlands, for example, the share of people aged 65 and above is expected to increase from 15% in 2008 to 26% in 2040 and health care expenses increase exponentially after the age of 65.[1,2] Although higher levels of health care expenditure are associated with old age, older people also hold potential to limit expenditure levels. By offering informal care, older people keep their partners, family-members, friends or neighbours away from the health care sector. Not much known is about the economic value of this preventive role of the older population.

It is plausible that informal care from spouse to spouse accounts for the biggest share expenditure prevention. It has been found that women offer the highest share of informal care, either as wives or daughters.[3] The contribution of men rises with age, and relates mainly to spouses.[4] Several authors have found that having a partner significantly decreases older people's risk of utilizing nursing home services.[5-9] However, these studies do not include expenditure levels and often do not look at the use of other health care services. The economic value of spousal informal care can be estimated by observing the difference in health care expenditure by people with a spouse with that of people who have no spouse, or no longer have a spouse. It has been found that the death of a spouse increases subsequent mortality risk,[10-12] health risks,[13] risk of long-term care utilization,[14,15] and medical care utilization.[16] In a study of 61 widows and widowers by Prigerson et al. (2000) it was estimated that widowed persons in the United States incurred up to 60% more health care expenditure than married persons.[17] Besides the observation in this small study, the effect of the death of the spouse on health care expenditure through time remains largely unknown.

Therefore, in a large and complete dataset of Dutch health care expenditure, we have investigated the impact of the death of the spouse on health care expenditure through time. We collected figures of individual health care expenditure within a large population over a long period of time from the database of a health care insurer, and linked this information with data on marital status. First, we analysed the effect of having a spouse and other socio-demographic determinants on health care expenditure in our total study population. Second, we focused only on clients who became widowed, and observed if individual levels of health care expenditure change before and after the death of the spouse. We also discerned whether there is a difference in this effect between men and women, younger and older people, and people with a lower and higher socio-economic status. Third, we investigated how expenditure levels for different

health services change before and after the death of the spouse. Insight into the economic value of formal care prevention by spouses is important for policy-makers who are concerned with improving the lives of older people and who are, at the same time, obliged to curtail ever rising levels of health care expenditure.

Methods

Ethics statement

After consulting the internal review board (IRB) of the regional health insurer, data on health care expenditure was retrieved from a health insurer. A formal waiver of IRB approval was received from the Central Bureau of Statistics (CBS) for data collection. After consulting the IRB of the CBS a single transfer of data from the health insurer to the Central Bureau of Statistics (CBS) was undertaken over a secure line. A formal waiver was received by the IRB of the CBS. After the data transfer, the CBS first removed any personal data. The leading author could then only access the de-identified data in a secured room of the CBS. The authors had no access to identifying information. Any output destined for publication was first scrutinized by the IRB of the CBS, so no output could be traced back to individuals. No data is publicly available. Data collection and analysis was in full accordance with privacy legislation and protocol.

Data

With the aim to perform multiple studies on the association between the life situation of older people and their health care costs, the *Leiden Health care Costs in Old Age* (LHCOA) study was started in 2011. For this study, data on health care expenditure for 61,495 people aged 65 and older in a period of 42 months were retrieved from a regional Dutch health insurer (*Zorg & Zekerheid*) and matched with data on socio-economic characteristics from the Central Bureau of Statistics (CBS). Data were collected in the following steps:

1. After consulting the internal review board (IRB) of the regional health insurer, data on medical care expenditure were retrieved from the health insurer's management information system. Data were collected for the period July 2007 through 2010 for all persons who lived in the regions where the health care insurer acted as the long-term care office, and who reached the age of 65 before 2011. Addresses were linked with data on socio-economic status by postal code, provided by the Netherlands Institute for Social Research.

2. Collecting data on expenditure for separate medical care services proved to be highly time consuming. These data were only retrieved for a subpopulation, randomized for socio-economic status. Eight separate services were identified: general practice, hospital, pharmacy, allied health care, psychology, instrumental aids, dental care, and other medical care.
3. In accordance with the IRB of the health insurer, data on long-term care utilization were collected from the EMEA Care Registration system (ECR), an information system which offers an oversight of all the coded messages that are sent between organizations active within the confounds of the EMEA. ECR messages designating the start and end of long-term care provision were linked with national average fees per volume unit, provided by the Health Insurance Board. The received volumes of extramural treatment were unknown, and no expenses could be calculated for this service.
4. After consulting the IRB of the CBS a single transfer of data from the health insurer to the CBS was done over a secure line. CBS staff merged the data using citizen service numbers and dismissed any personal data afterwards. The authors could then only access the de-identified data in a secured room of the CBS. The authors had no access to identifying information. Any output destined for publication was first scrutinized by the IRB of the CBS, so no output could be traced back to individuals. No data is publicly available. Data collection and analysis was in full accordance with privacy legislation and protocol. Socio-demographic variables collected at the CBS were: age, gender, marital status, and time of death.
5. After these steps, the total study population comprises 61,495 subjects. Expenditure for separate medical care services are known for 18,995 subjects.

A more detailed description of the data collection procedure can be found in supplementary figure 1 (page 102), which presents a flowchart of the procedure.

Statistical analysis

In the overall analysis, we used the total study population (n=61,495) to investigate what influence gender, age, marital status, socio-economic status (SES), and calendar year have on monthly health care expenditure (HCE). All determinants are defined as categorical variables. We defined two groups for age (65-79 years old, and 80 years and older) and SES (score < 6.45 and score ≥ 6.45) based on the medians (age=77 years; SES score=6.44). As there are multiple monthly observations for each subject in our dataset, and HCE is skewed to the right, leptokurtic and heteroskedastic, we used a linear mixed model with a log transformation of HCE (LLMM). Visual inspection of the distribution

of the residuals in the model now showed a normal distribution. The model can be expressed with the following equation:

$$(1)\ ln(H_{ij}) = \beta_0 + \beta_1 G + \beta_2 AG + \beta_3 M + \beta_4 SG + \beta_5 Y + \varepsilon$$

where *H* stands for HCE for individual *i* in month *j*, *G* for gender, *AG* for age group, *M* for marital status, *SG* for socio-demographic status group, and *Y* for calendar year. To estimate the effect of each determinant in the equation, we calculated the exponential function of each β in the equation.

Hereafter, the focus was shifted to the subjects who became widowed in the period 2004-2011 (n=6,487). Data on marital status was available for a longer time period (2004-2011) than data on HCE (July 2007-2010). This way, we could measure the impact of the death of the spouse on HCE with a maximum time span of 42 months before and 42 months after the month in which the subjects became widowed. A LLMM was used to estimate HCE for every month. Standardization was applied for socio-demographic variables and calendar year by holding them constant on the mean. Monthly point estimates of HCE before and after the loss of the spouse were also calculated for different socio-demographic groups: both genders, two age groups, and two socio-economic status groups. The LLMM used in the second analysis can be expressed with the following equation:

$$(2)\ ln(H_{ij}) = \beta_0 + \beta_1 G + \beta_2 A + \beta_3 S + \beta_4 Y + \beta_5 MW_{ij} + \varepsilon$$

where *H* stands for HCE for individual *i* in month *j* (*j* =–42 to +42), *G* stands for gender, *A* for age, *S* for socio-demographic status score, *Y* for calendar year, and *MW* for each month before or after widowhood.

Monthly points estimates will provide eye evidence on a possible effect of widowhood on HCE. To test whether the level of HCE during widowhood differs significantly from the period before widowhood, we compared the mean monthly levels of both periods in a two-sample t-test. The means of HCE for each period were calculated from the estimates from the LLMM (equation 2).

In analysing the effect of the loss of the spouse on expenditure levels in specific health services, we selected subjects for whom expenditure were known for each separate medical care service and who became widowed from 2004 to 2011 (n=2,027). For some health services, only a relative low number of subjects received care. As the outcome variables were thus not only characterized by problems with skewness, kurtosis and heteroskedasticity, but also with a high share of zero values, a LLMM could not be

applied. Therefore, we first pooled monthly expenses of each health service for every subject, and then used either a generalized linear model (GLM) or two-part model (2PM) with a logit model for the first part, and a GLM with gamma distribution and a log link for the second part.[18,19] The GLM can be expressed as:

$$(3)\ g(T_{ip}) = \eta_{ip} = \beta_0 + \beta_1 G + \beta_2 A + \beta_3 S + \beta_4 Y + \varepsilon$$

where g is the link function, and T stands for average monthly expenditure for a specific health service for individual i in period p, G stands for gender, A for average age, S for socio-demographic status, and Y stands for average calendar year. The 2PM is expressed as:

$$(4)\ E\left(T_{ip}\middle|\boldsymbol{x}'_{ip}\right) = \Pr\left(T_{ip} > 0\middle|\boldsymbol{x}'_{ip}\right) \times \eta_{ip}$$

where x' expresses the set of determinants, and η the GLM (see equation 3 for x' and η). For each health service, comparison of the average monthly expenditure levels before the loss of the spouse with the average level after the death of the spouse was performed with a two-sample t-test.

Results

The study populations

The descriptive statistics of the total study population, the widowed population and the widowed subpopulation can be found in table 1. First, we analysed the effects of socio-demographic characteristics on health care expenditure (HCE) in the total population (n=61,495). Hereafter, we included those subjects who lost their spouse in the period 2004-2011 to investigate the impact of the death of the spouse on HCE (n=6,487). The majority of these widowed subjects are women (71%). The average follow-up before the death of the spouse is 11.6 (±14.6) months, and after the death of the spouse 16.8 (±12.8) months, both with a maximum of 42 months. For the analysis concerning expenditure for different health services, a widowed subpopulation was used (n=2,027). Characteristics of the widowed subpopulation are similar to the total widowed population.

Table 1. Characteristics of the study populations.[a]

	Total population	Widowed population	Widowed subpopulation
	Number (%)	*Number (%)*	*Number (%)*
Study population	61,495	6,487	2,027
Gender			
Men	24,904 (40%)	1,854 (29%)	590 (29%)
Women	36,591 (60%)	4,633 (71%)	1,437 (71%)
Age			
65-79	39,113 (64%)	4,729 (73%)	1,442 (71%)
≥ 80	12,010 (20%)	1,758 (27%)	585 (29%)
Marital status			
Married	35,291 (57%)	3,139 (48%)	991 (49%)
Widowed	16,819 (27%)	3,348 (52%)	1,036 (51%)
Divorced	5,742 (9%)	- -	- -
Never married	3,643 (6%)	- -	- -
Socio-economic status (SES)			
Lower (SES score < 6.45)	30,633 (50%)	3,288 (51%)	1,232 (61%)
Higher (SES score ≥ 6.45)	30,862 (50%)	3,199 (49%)	795 (39%)

[a] Descriptive statistics are all baseline figures.

Effects of socio-demographic characteristics on health care expenditure

Table 2 shows the impact socio-demographic determinants have on HCE in the total study population (n=61,495). In the total population, mean monthly health care expenditure is €629. The level of HCE for widows and widowers is €329 higher than for married people, which equals 52% of the mean. HCE for divorced subjects is €49 (8%) higher, and for those never married HCE is €196 (31%) higher compared to married subjects. On average, women have €20 (3%) more HCE per month than men, and subjects of 80 years or older have €316 (50%) more HCE than their younger counterparts. Expenditure levels are €25 (4%) lower for subjects with a higher socio-economic status than for subjects with a higher socio-economic status.

Table 2. The effect of socio-demographic characteristics on health care expenditure (HCE) in the total study population (n=61,495), from July 2007 through 2010. Average monthly HCE of the study population is €629.

	Effect size[a]	
	(€/month)	*p*
Gender		
Men	Ref	
Women	+20	.002
Age		
65-79	Ref	
80+	+316	<.001
Marital status		
Married	Ref	
Widowed	+329	<.001
Divorced	+49	<.001
Never married	+196	<.001
Socio-economic status (SES)		
Lower SES group	Ref	
Higher SES group	–25	<.001

[a] Results are coefficients and their p-value from a linear mixed model with log transformation.

The effect of the death of the spouse on health care expenditure

In the second analysis, we only focus on the subjects who became widowed in the period 2004-2011. As can be seen from figure 1 (upper panel), HCE rises gradually before the loss of the spouse and shows a steep increase in four months around the month the spouse died. The month in which a subject became widowed is defined as 'month 0', and depicted as a vertical dotted line.

After the initial rise in HCE after the death of the spouse, there is a slight decline in HCE. As these results are unstandardized, results could be influenced by a rise in the mean age, changing shares of men vs. women and lower vs. higher socio-economic classes, as well as rising health care prices. For this reason, we regressed the monthly HCE on the months before and after the death of their spouse in a linear mixed model with log transformation.

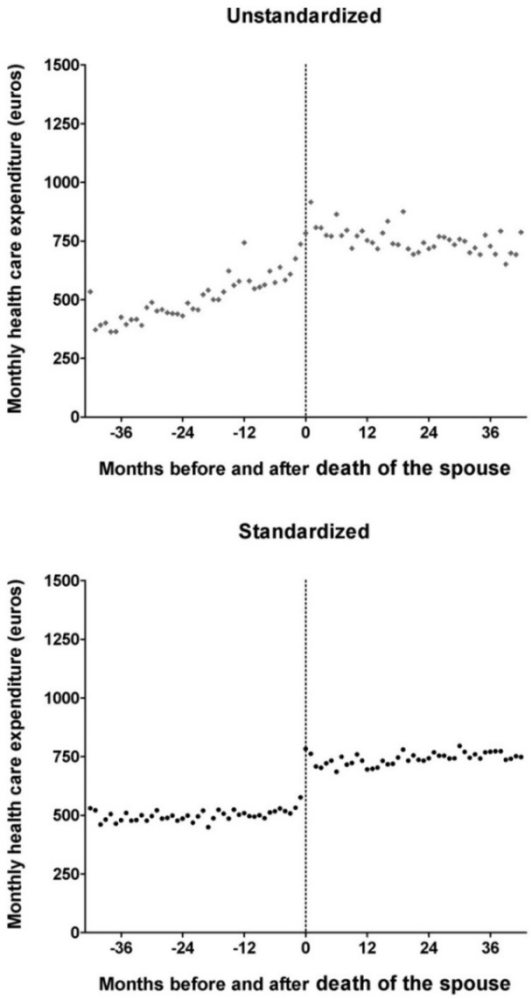

Figure 1. Monthly health care expenditure (HCE) before and after death of the spouse (n=6,487). The upper panel represent the raw data. The lower panel is from a linear mixed model with log transformed HCE, standardized for gender, age, socio-economic status, and calendar year.

Figure 1 (lower panel) shows the monthly point estimates from the regression model, standardized for age, gender, socio-economic status score, and calendar year. With standardization, HCE shows no more gradual rise before the loss of the spouse, and no slight decline afterwards. There is a sudden increase in HCE of €207 (36%) in the month the subjects lose their spouse.

Figure 2 shows the monthly points estimates of HCE in the months before and after the loss of the spouse for both genders (panel a), two age groups (b) and two SES groups (c). The expenditure level of men rises to a higher level after the death of the spouse than for women. After the loss of the spouse, men have a continual increase in HCE, while the level of women remains more stable. Individuals in the older age group have higher levels of HCE than their younger counterparts before and during widowhood. An increase in monthly HCE starts to set in earlier for the older age group (around 7 months before death of the spouse) than for the younger age group, for which no real increase in HCE is noticeable prior to widowhood. Widowed subjects in the lower SES group require slightly less HCE before and after the death of the spouse. Individuals of a higher socio-economic class have a small, continual rise in HCE after the death of the spouse.

The mean levels of HCE in the 42 months before and after the loss of the spouse in the widowed population, and different socio-demographic groups, are shown in table 3. Overall, HCE is €239 higher in the 42 months after the death of the spouse than in the 42 months before, which is equal to a rise of 48% (p=.01). With €319 (59%; p=.116) the rise in HCE is higher for men than for women (€209; 43%; p=.042). When still married, individuals in the older age group have higher levels of HCE (€678) than their younger counterparts (€381). This difference further increases after the death of the spouse: HCE for the older age group rises with €553 (82%; p=.028) and for the younger age group with €124 (32%; p=.12). The level of HCE for individuals from the higher socio-economic group is higher before and after the death of the spouse, but the relative increase due to widowhood is lower (45% vs. 50%). However, this rise in HCE after the death of the spouse is not significant for both socio-economic groups.

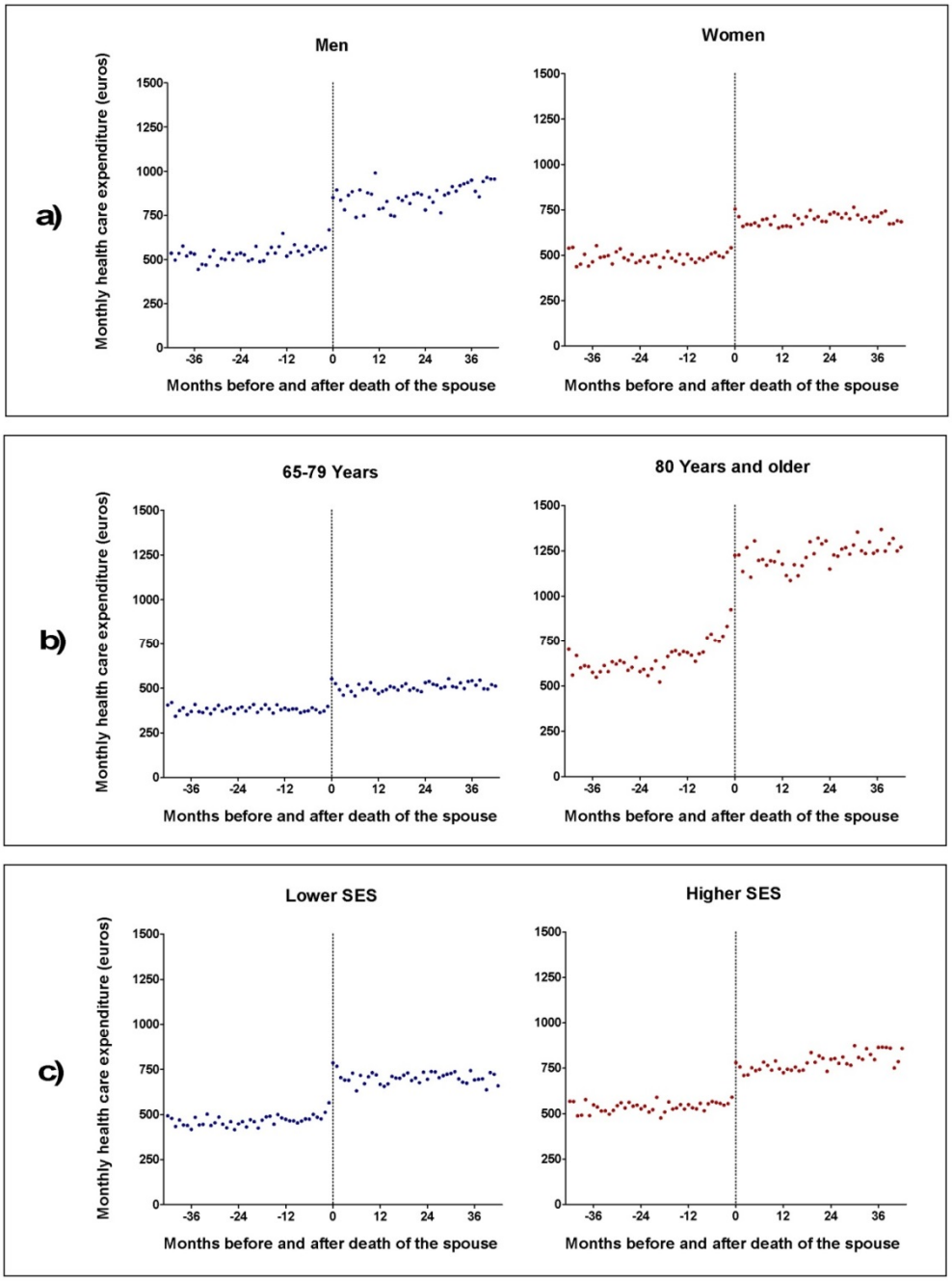

Figure 2. Monthly health care expenditure before and after the death of the spouse for both genders (a), two age groups (b) and two SES groups (c). Point estimates are from a linear mixed model with log transformed health care expenditure, standardized for gender, age, socio-economic status and calendar year.

Table 3. Differences in health care expenditure (HCE) in the 42 months before and after death of the spouse (population of widowed subjects, n=6,487).

	Mean monthly HCE (€)[a]		*Difference*		
	Before death of the spouse	After death of the spouse	€	%	p
All	**502**	**741**	**239**	**48**	**.010**
Gender					
Men	540	859	319	59	.116
Women	489	698	209	43	.042
Age					
65-79	381	505	124	32	.120
80+	678	1231	553	82	.028
Socio-economic status					
Lower SES group	469	703	234	50	.056
Higher SES group	539	784	245	45	.077

[a] Mean monthly levels of HCE are from a linear mixed model with log transformed HCE, standardized for gender, age, socio-economic status, and calendar year (see figure 1 and 3).

The effect of the death of the spouse on expenditure for separate health services

In table 4, the association between HCE and widowhood over time is shown for each health service in a subpopulation of 2,027 widows and widowers. With €271 (56%;p<.001) the overall effect size of the death of the spouse on HCE is similar to the total widowed population. The rise in the absolute level of expenditure levels after the death of the spouse is slightly larger in the medical care (€140; p<.001) sector than in the long-term care sector (€131; p<.001). However, the relative rise is five times smaller in the medical care sector than in the long-term care sector (30% versus 157%). Expenditure for nursing home care shows the highest relative increase after the death of the spouse with 163%, although this increase is not significant (p=.057). Expenditure for hospital services increases the most in the absolute sense (€110 per month; p<.001). The lowest absolute increase takes place in the field of general practice (€4; p<.001).

Table 4. Differences in health care expenditure (HCE) in the 42 months before and after the death of the spouse for separate health services, standardized for gender, age, socio-economic status and calendar year (subpopulation of widowed subjects, n=2,027).

	Mean monthly HCE (€)		*Difference*		
	Before death of the spouse	After death of the spouse	€	%	*p*
Total[a]	**486**	**757**	**271**	**56**	**<.001**
Medical care[a]	**379**	**519**	**140**	**30**	**<.001**
General practice[a]	18	22	4	23	<.001
Hospital[b]	196	306	110	56	<.001
Pharmacy[a]	78	84	6	8	.219
Other[b,c]	87	106	20	23	.288
Long-term care[b]	**107**	**238**	**131**	**157**	**<.001**
Home care[b]	55	111	56	103	<.001
Counselling[b]	12	27	15	120	.017
Care home[b]	11	24	14	132	.051
Nursing home[b]	16	43	27	163	.057
Other[b,d]	13	32	19	144	.013

[a] Results are from a generalized linear model (GLM).

[b] Results are from a two-part model with logit model in the first part, and GLM in the second.

[c] Dental care, allied health care, mental health care, transportation, instrumental aids, acupuncture, and others.

[d] Long-term rehabilitation, palliative care, care for the disabled, and long-term mental health care.

Marriage protection, marriage selection, a shared environment, bereavement

Since spouses can provide each other with intensive levels of informal care, one could argue that marriage has preventive effects on formal care use. Although the loss of a spouse is treated as an exogenous shock, different endogenous factors could be at play in the association between widowhood and health care expenditure. One could argue from a marriage selection perspective.[20] People tend to select their spouse on the basis of similar characteristics, such as age, intelligence, educational level, and psychological well-being.[21,22] Because spousal partners are similar in these traits, it is likely that their health care expenditure levels also show similar patterns over time, regardless of life events. Another plausible explanation is that married couples share a similar environment and are thus susceptible to equal risk factors.[23] Both effects cause widowed people to make more use of health services, not because of the death of the spouse, but because they have a higher chance of being ill, just as their partner was. We accounted for these

endogenous factors to the best of our ability by standardizing for socio-demographic factors.

Bereavement is also related to health risks, and could therefore induce higher health care expenditure.[24,25] The point estimates portrayed in figures 2 and 3 suggest that bereavement plays a minor role in the association between widowhood and health care expenditure as there is no peak in expenditure in the months after the death of the spouse. Also, the increase in health care expenditure after the death of the spouse is five times higher in the long-term care sector than the medical care sector. This suggests that expenditure levels predominantly rise because there is a higher need for formal care after the loss of an informal care-giver, rather than a higher need for medical treatment related to the health impact of bereavement, marriage selection or a shared environment.

Other studies take the effects of marriage selection, a shared environment, and bereavement into account by directly measuring the 'substitution' effect of informal care reception on health care utilization.[26-31] These authors show that informal care has a preventive role, or in other words, that care provided by spouses, family members, and friends substitutes for formal health care. It is plausible that this substitution effect is a major contributing factor to the association we found between widowhood and health care expenditure. Because our data are retrieved from a follow-up study, we can separate the direct effects of bereavement, and by standardizing for age and socio-economic status we have at least partly avoided the interference of marriage selection and a shared environment.

The economic value of informal care and prevention programs

Our findings are particularly useful for economists studying the impact of human behaviour or the costs and benefits of prevention programs. Because informal care is not financially compensated, it is usually not taken into account in economic analyses. In literature, it remains unclear what the best method is to express informal care in economic terms.[32] The economic value of formal care use prevention can be used as a method to value the dynamics of informal care as an alternative to, for example, the 'proxy-good method,'[33] or the 'willingness-to-pay method.'[34] Research on the economic burden of smoking is an example of a field in which the economic valuation of informal care is lacking. Some authors have concluded that smoking benefits the economy, because smokers usually don't reach higher, more expensive ages.[35-37] However, these studies focus only on individual health care expenditure during the life course and fail to take into account that people outliving their smoking partners have a higher chance of requiring formal care. A part of the higher average levels of life course health care

expenditure of non-smokers is thus caused by smoking partners who cause second-hand smoke and die younger. Consequently, when the effect of second-hand smoke and informal care are taken into account in these analyses, the real costs of smoking are higher than currently reported.

This study can also benefit policy-makers and physicians. For example, results show that health care expenditure of older people is not only higher after the death of the spouse, but also in the months before widowhood. Emotional stress and a higher burden of informal care could be an underlying dynamic. It is also possible that some subjects postponed the use of health care services for themselves until intensive care for their dying spouse was no longer required. Intervention programmes including information, support, therapy, and respite care for older people providing intensive care for their spouses could have financial merit besides any potential beneficial effects on well-being.[38] Similarly, widows and widowers may benefit from an expanded role for general practitioners. Older people can suffer from confusion, apathy, dependency, and depression after the death of their spouse. A pro-active general practitioner can assist and support those recently widowed to improve their independence and well-being, also diminishing the need for medical treatment or care in the long run.[39] Our results suggest there is room for such interventions, as the level of expenditure in the sector of general practice increases just slightly (€4 per month) after the death of the spouse.

An important strength of our paper is that individual characteristics and expenditure levels were collected within a large study population over a relatively long time period (July 2007 through 2010). However, we could only collect data on marital status and some widows and widowers will have started a new relationship outside the bonds of marriage. Also, information on the causes of death of the spouse, or the actual reception of informal care before widowhood was missing. Additionally, the effect of the death of the spouse on health care expenditure is likely mediated by the presence of children, as well as other family members or friends. On the other hand, not all widowed subjects from our study received informal care prior to widowhood, showing that informal care provided in spousal relations is economically more valuable than the extra 239 euros per month that widowed people cost. Hence, we want to emphasize that we have measured the effect of having a spouse on health care expenditure and not the effect of informal care per se.

To our knowledge, we are the first to perform an in depth investigation into the effect of the loss of a spouse on health care expenditure through time. Our results are in line with previous papers on the utilization of health care by widowed people. Our research not only points out the value of informal care to society in economic terms, but

also provides further basis to develop interventions for the support of widows and widowers. This way, future financial strains on the health care system can be avoided, and, more importantly, the quality of life of widows and widowers can be improved.

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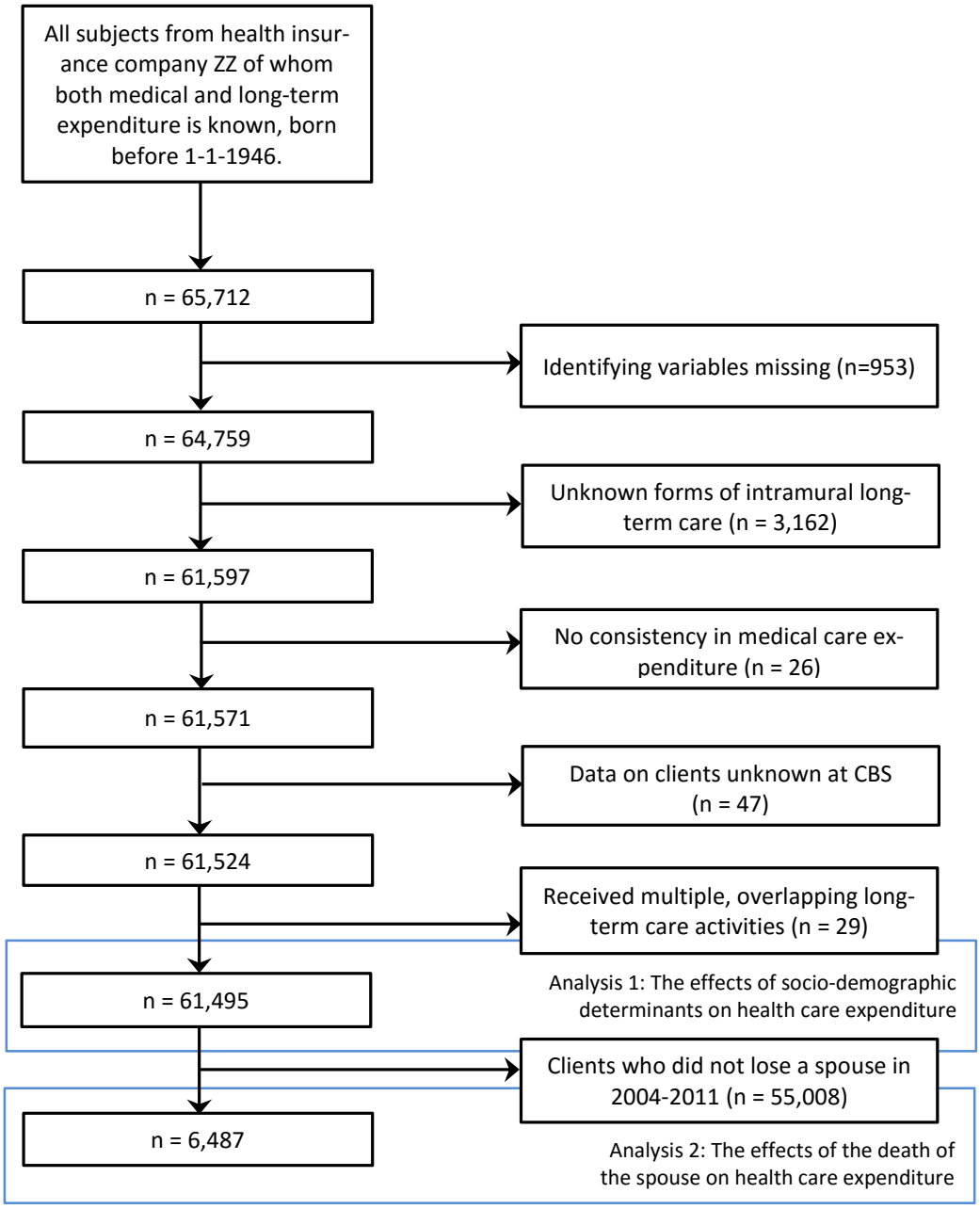
Supplementary material



Supplementary figure 1: Flowchart of data collection.

Chapter 7

Variation in the costs of dying and the role of different health services, socio-demographic characteristics, and preceding health care expenses

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Abstract

Background: The health care costs of population ageing are for an important part attributable to higher mortality rates in combination with high costs of dying. This paper answers three questions that remain unanswered regarding the costs of dying: (1) contributions of different health services to the costs of dying; (2) variation in the costs of dying; and (3) the influence of preceding health care expenses on the costs of dying.
Methods: We retrieved data on 61,495 Dutch subjects aged 65 and older from July 2007 through 2010 from a regional health care insurer. We included all deceased subjects of whom health care expenses were known for 26 months prior to death (n=2,833). Costs of dying were defined as health care expenses made in the last six months before death. Lorenz curves, generalized linear models and a two-part model were used for our analyses.
Results: The average costs of dying are €25,919. Medical care contributes to 57% of this total, and long-term care 43%. The costs of dying mainly relate to hospital care (40%). In the costs of dying, 75% is attributable to the costliest half of the population. For medical care, this distribution figure is 86%, and for long-term care 92%. Age and preceding expenses are significant determinants of this variation in the costs of dying. Overall, higher preceding health care expenses are associated with higher costs of dying, indicating that the costs of dying are higher for those with a longer patient history.
Conclusions: There is not a large variation in the costs of dying, but there are large differences in the nature of these costs. Before death, the oldest old utilize more long-term care while their younger counterparts visit hospitals more often. To curb the health care costs of population ageing, a further understanding of the costs of dying is crucial.

Introduction

Health care expenses in many ageing populations continue to rise.[1] However, ageing itself is only a minor determinant of this rise. First, because the growing share of older people in many nations has only a marginal influence on the rise in health care expenses. Other factors – such as technological innovations – are found to be more important drivers of this rise.[2,3] Second, many studies show that, on an individual level, health care expenses increase manifold in the time close to death and overshadow rises in expenses due to advanced age alone.[4-7] Since health care expenses made at the end of life play a relatively large role in total health care cost levels, it is important to understand what factors influence these expenses. Many studies exist that discern the influence of different factors on health care expenses before death, but there are still gaps in literature that prevent social scientists, clinicians and policy-makers to gain a full understanding.

There is little insight into how the different health service types are affected by impending death. With some exceptions,[8-12] all studies investigating the effect of proximity to death on health care expenses focus on one sector or service type – often the hospital. De Meijer (2011) and Wong et al. (2011) have also focused on Dutch data, and analysed the costs of dying in long-term care and hospital care respectively.[13,14] However, to our knowledge we the first to study the costs of dying for all health service types – including general practice, pharmacy, counselling, and hospices – using subjects from a single database.

Second, although authors have shown clear evidence that certain factors raise or lower the level of health care expenses before death, it remains unknown whether there are large differences in the costs of dying between individuals and what factors have the largest influence on this variation. Studies show that the expenses before death decrease with age in the medical care sector,[15-18] but increase in the long-term care sector.[11] Also, it has been found that women have higher levels of health care expenses in general and close to death,[11] but is unclear whether this a gender effect or a widowhood effect. Women have lower mortality rates than men, increasing their chance of being widowed, and it has also been found that subjects without a partner have higher levels of health care utilization and expenditure, also prior to death.[19-22] Besides socio-demographic characteristics, cause of death seems to play a role in the level of health care costs before death. It has been found that expenses before death are highest for cancer, and lowest for cardiovascular diseases, although other causes of death have no significant impact.[23,24]

Third, it is unknown whether individuals with a longer history of illness or disability have higher or lower costs of dying. It has been shown that health care expenses start rising as early as 31 months before death,[25] but it is unclear whether higher expenses at this time are associated with relatively higher or lower expense levels just before death. It is possible that death comes more unexpected for individuals who had an overall lower morbidity level, leading to more intensive and aggressive treatment at the end of life. Earlier health care expenditure levels form a decent indicator an individual's history of morbidity. It has been found that whites and females have higher health care expenses in general than others, but lower levels close to death.[18,26] This stands in contrast to the finding that higher expenses are incurred in the last year of life for people with a higher cardiovascular risk profile earlier in life.[27] To summarize, it remains unclear how large the variation is in the costs of dying, and what socio-demographic factors are contributors to variation.

Therefore, we performed an analysis of the variation in the costs of dying, and the factors that have a possible influence on this variation. First, we calculate the costs of dying in the study population, and we further divide expenses by health service type, to see which types are affected most by impending death. Second, we portray the variation in the costs of dying in a Lorenz curve. Hereafter, we provide an oversight of what factors influence a potentially skewed distribution. Thirdly, we include preceding health care expenses in our analysis.

Methods

Data

With the aim to perform multiple studies on the association between the life situation of older people and their health care costs, the *Leiden Health care Costs in Old Age* (LHCOA) study was started in 2011. For this study, data on health care costs for 61,495 people aged 65 and older in a period of 42 months were retrieved from a regional Dutch health insurer (*Zorg & Zekerheid*) and matched with data on socio-economic characteristics from the Central Bureau of Statistics (CBS). Data were collected in the following steps:

1. After consulting the IRB (legal department) of the regional health insurer, data on medical care expenditure were retrieved from the health insurer's management information system. Data were collected for the period July 2007 through 2010 for all persons who lived in the regions where the health care insurer acted as the long-term care office, and who reached the age of 65 before 2011. Addresses were linked

with data on socio-economic status by postal code, provided by the Netherlands Institute for Social Research.

2. Collecting data on medical care expenditure by service type proved to be highly time consuming. These data were only retrieved for a subpopulation, randomized for socio-economic status. Eight service types were identified: general practice, hospital, pharmacy, allied health care, psychology, instrumental aids, dental care, and other medical care.
3. In accordance with the IRB of the health insurer, data on long-term care utilization were collected from the EMEA Care Registration system (ECR), an information system which offers an oversight of all the coded messages that are sent between organizations active within the confounds of the EMEA. ECR messages designating the start and end of long-term care provision were linked with national average fees per volume unit, provided by the Health Insurance Board. The received volume of extramural treatment were unknown, and no costs could be calculated for this service type.
4. After consulting the IRB of the CBS a single transfer of data from the health insurer to the CBS was done over a secure line. CBS staff merged the data using citizen service numbers and dismissed any personal data afterwards. The authors could then only access the de-identified data in a secured room of the CBS. The authors had no access to identifying information. Any output destined for publication was first scrutinized by the IRB of the CBS, so no output could be traced back to individuals. No data is publicly available. Data collection and analysis was in full accordance with privacy legislation and protocol. Socio-demographic variables collected at the CBS were: age, gender, marital status, and time of death.
5. After these steps, the total study population comprises 61,495 subjects. Medical care costs by service type are known for 18,995 subjects.

The total study population of the LHCOA study (n=61,495) was split up into two groups: subjects who died in the studied time period (n=9,202), and those that survived (n=52,293). We defined the costs of dying as the expenses in the last six months before death. We selected average expenses made two years prior to death to represent preceding health care expenses. To retrieve a more robust estimate of these preceding health care expenses, and to be better able to compare these expenses with the costs of dying, we used the 26th through 21st month prior to death. From the group of subjects who died before 2012, we then selected only those for which health care expenses were known from the 26th month before death to the month of death (deceased population, n=2,844). Medical care expenses per service type were known for 926 subjects. In the

population of surviving subjects, we selected those for whom health care expenses were known in 26 consecutive months in the same calendar time period as the deceased group. This group is referred to as the non-deceased group (n=42,204). In the non-deceased group, medical care expenses per service type were known for 12,996 subjects.

Statistical analysis

Regression models were used to test the association between different determinants and health care expenditure. As the distribution of health care expenditure is skewed and the association with the determinants is subject to heteroskedasticity, we used a generalized linear model GLM with gamma distribution and a log link.[28] Many zero outcomes were encountered in the data on long-term care expenditure (25%), implying that an analysis with a two-part model is needed for this sector.[29] The number of zero outcomes were relatively small for the medical care sector (2.5%) and for total health care (<.01%). In our two-part model, we chose to use a probit model for the first part, and a GLM with gamma distribution and a log link for the second part.[14]

First, to retrieve insight into the costs of dying we calculated mean figures on health care expenses from the deceased group for every month before death (up to the 26th month before death). For comparison, the average monthly cost levels of the non-deceased group were calculated, whereby the socio-demographic characteristics and calendar month were standardized on the means of the determinants in the deceased group. Second, the expenses in the last six months before death were calculated for different health service types. For each service type, the expenses in the last six months before death were compared with the expenses over a similar time period two years before death (26th through 21st month). Third, a Lorenz curve was made to portray the variation in the costs of dying. Specifically, the curve shows how the expenses in the last six months before death are distributed throughout the population. Fourth, we investigated if socio-demographic characteristics, calendar time and preceding expenses could be associated with lower or higher levels in the costs of dying. A time variable (calendar month) was used because health care expenses change over time, mainly due to inflation and health care reforms. To test whether the association between the costs of dying and preceding expenses was sensitive to the choice of the time period used to define preceding expenses, we also ran analyses in which preceding expenses were defined for the 29th through 24th month as well as the 24th through 19th month before death.

Results

Table 1 shows the population characteristics of the deceased and non-deceased group. Age was divided into two groups based on the median of the deceased group. Socio-economic status was classified on the basis of the median of the Dutch population.

Health care expenses before death

The left panel in figure 1 shows the trajectory of health care expenses before death. For comparative purposes the right panel of figure 1 shows the monthly expenses of the non-deceased. Health care expenses are higher in the deceased, at least up to 26 months prior to death. With €955, the level of monthly expenses in the 26th month before death is ±2 times the average monthly level of the non-deceased group. Spending rises steeply around six months before death. With €9,387 the relative difference increases to ±12.4 in the last month before death.

Table 1. Characteristics of the study population.[a]

Socio-demographic group	Deceased (n=2,844)		Non-deceased (n=42,204)	
Gender				
Men	1,349	(47%)	20,537	(39%)
Women	1,497	(53%)	31,756	(61%)
Age				
< 75	836	(29%)	25,090	(85%)
75-85	1,309	(46%)	14,419	(34%)
≥ 85	699	(25%)	2,695	(6%)
Marital status				
Married	1,148	(40%)	23,839	(56%)
Widowed	1,331	(47%)	12,279	(29%)
Divorced	179	(6%)	3,836	(9%)
Never married	186	(7%)	2,250	(5%)
Socio-economic status (SES)[b]				
Lower	724	(25%)	9,591	(23%)
Higher	2,120	(75%)	32,613	(77%)

[a] Figures are from the first month of follow-up.

[b] The demarcation between lower and higher SES group is based on the national average (=6.10).

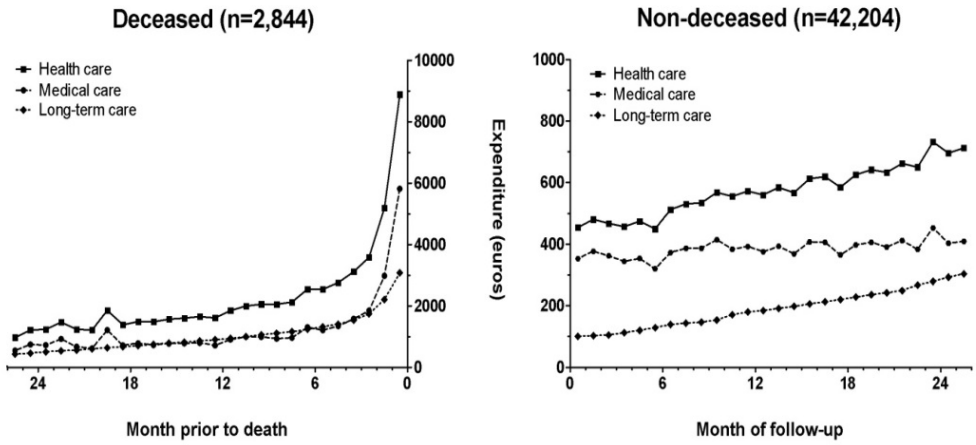

Figure 1. Patterns in monthly costs of the deceased and non-deceased. Figures depict health care expenses, split up in medical care expenses and long-term care expenses, in the last 26 months before death for the deceased group (left panel) and in 26 months in the same time period for the non-deceased population (right panel). Expenses of the non-deceased are standardized on the mean socio-demographic characteristics of the deceased population for every month. Note the differences in the y-axes.

Medical care expenses have a trajectory similar to that of total health care expenses. From the 26th to the last month before death, expenses rise from €525 to €6,315. The level of monthly medical care expenses of the deceased relative to the non-deceased group increases from 1.5 to 14.6. Long-term care expenses rise more gradual from the 26th to the last month before death (from €430 to €3,072), although expenses double in the last 3 months of life. For long-term care, the ratio of monthly expenses of the deceased to the non-deceased increases from 3.8 to 8.7.

Notable from figure 1 is that average long-term care expenditure in the non-deceased group rises from €101 to €304 in 26 months time. Investigation of the data reveals that in this time period the long-term care utilization rate of the non-deceased increases with 86% (from 5.8% to 10.8%). Average fees per volume in long-term care increase with 9%, and the average care weight rises with 44%. These changes explain 97% of the threefold rise in long-term care expenditure, and are partly related to the ageing of the non-deceased population in these 26 months (mean age rises from 80.1 to 82.2 years).

In table 2 the expenses in the last six months before death of a random subgroup (n=926) are split up in different service types. Mean expenditure in the 26th through 21st month before death in this subgroup is €7,249. With €25,919, average expenditure

in the last six months before death is 3.6 times as high. Hospitals, home care and nursing homes make up the highest shares in the expenses in the last six months before death, totalling €16,945 (65%). Hospital expenses in the last six months before death increase from €2,223 to €10,449. Consequently, the share of hospital expenses increases from 31% to 40%. Expenses for home care increase from €1,524 to €3,542 (from 21% to 14%), and expenses for nursing home care increase from €350 to €2,954 (from 5% to 11%). In the last six months before death, cost shares are lowest for care from general practitioners and hospices (3.3% and 1.3% respectively).

Table 2. Preceding health care expenses and the costs of dying by service type.

Service type	Preceding health care expenses,[a] in € (%)		Costs of dying,[b] in € (%)	
Health care	**7,249**	**(100%)**	**25,919**	**(100%)**
Medical care	**4,240**	**(58.5%)**	**14,793**	**(57.1%)**
General practice	139	(1.9%)	851	(3.3%)
Hospital	2,233	(30.8%)	10,449	(40.3%)
Pharmacy	905	(12.5%)	1,564	(6.0%)
Other[c]	961	(13.3%)	1,931	(7.5%)
Long-term care	**3,009**	**(41.5%)**	**11,126**	**(42.9%)**
Home care	1,524	(21.0%)	3,542	(13.7%)
Counselling & day-time activities	447	(6.2%)	1,593	(6.1%)
Care home	454	(6.3%)	1,460	(5.6%)
Nursing home	350	(4.8%)	2,954	(11.4%)
Hospice	0	(0.0%)	349	(1.3%)
Other[d]	234	(3.2%)	1,227	(4.7%)

Means are of all clients in the deceased population of whom expenses by medical service type are known (n=926, see methods section). Therefore, total mean costs are slightly different from the whole sample of 2,844 deceased subjects due to sample variation.

[a] Preceding health care expenses are made in the 26th through 21st month before death.

[b] The costs of dying are the expenses made in the last six months before death.

[c] Physiotherapy, psychotherapy, acute mental care, dental care, instrumental aids, etc.

[d] Long-term rehabilitation, care for the handicapped and mentally ill.

Variation in the expenses in the last six months before death

The Lorenz curves in figure 2 shows the distribution of expenses in the last six months before death in the population of deceased subjects (n=2,844). The share of these expenses is set against the share of the population. Panel a shows that the 50% of the population with the highest expenses in the last six months before death contributes to 75% of the total expenses prior to death. Concerning medical care, the more expensive

half represents 86% of the total medical care expenses prior to death (panel b). The distribution figure is 92% for long-term care (panel c).

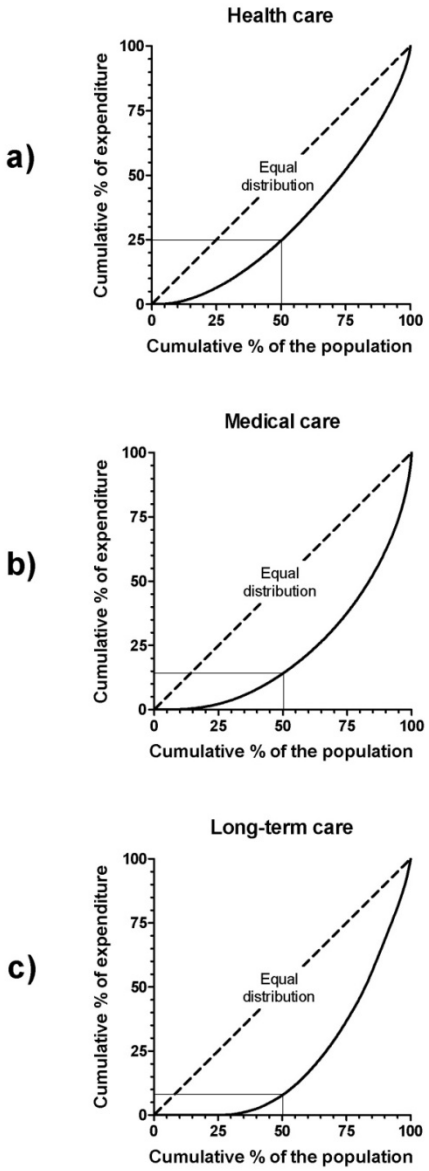

Figure 2. Variation in the cost of dying. The population distribution of the costs of dying (expenses in the last six months before death) in 2,844 individuals is shown for total health care (panel a), and split up in medical care (b) and long-term care (c).

Table 3 shows if and how socio-demographic characteristics, calendar time and preceding health care expenses (expenses in the 26th through 21st month before death) influence the expenses in the last six months before death. The average health care expenses in the last six months before death are €25,790. Age is a significant determinant of these expenses. For every year gained, expenses in the last six months of life decrease with €257, which equals 1% of the average total (p<.001). The mean difference in health care expenses in the last six months of life between a 65 and 85 year old subject is then €5,140, which equals 20% of the average. Calendar time is also a significant determinant: health care expenses in the last six months of life increase with €185 every calendar month (+0.7%; p=.014).

Mean medical care expenditure in the last six months before death is €14,493. Medical care expenses in the last six months before death decrease with €479 for every year the age at death increases (–3%; p<.001). The mean difference in medical care expenses in the last six months before death between a 65 and 85 year old subject is therefore €9,580 (–66%). Subjects that were never married have significant lower medical care expenses in the six months before death with €3,287 (–23%; p=.010). Mean long-term care expenditure in the last six months before death is €11,298. Expenses in the last six months before death increase with €227 per year in this sector (+2%; p<.001). Consequently, this is a €4,540 rise from the ages 65 to 85 (+40%).

Gender and marital status also play a significant role in long-term care expenditure in the last six months before death. On average, women make €1,724 more long-term care expenses in the last six months before death than men (+16%; p<.001). Expenses by subjects who never had a spouse are €4,376 higher than expenses by married subjects (+39%; p=.001). Calendar time is also a significant determinant of long-term care expenses in the last six months before death (+€89; +0.5%; p=.048).

Table 3 also shows that preceding health care expenses are significantly associated with health care expenses in the last six months before death. For every additional €1,000 spent on health care in the 26th through 21st month before death, health care expenses in the last six months before death rise with €274 (p<.001). Higher expenses in the medical care sector in the 26th through 21st month before death are associated with higher medical care expenses in the last six months before death (+€182; p<.001). If preceding expenses in the long-term care sector increase with €1,000, long-term care expenses in the last six months before death rise with €759 (p<.001), but medical care expenses lower with €434 (p<.001). Using other time periods to indicate preceding expenses (29th through 24th month; 24th to 19th month) yields similar results.

Table 3. The association of the costs of dying with socio-demographic characteristics, calendar time and preceding health care expenses.

	Health care *mean = €25,790*			**Medical care** *mean = €14,493*			**Long-term care** *mean = €11,298*		
	€	95% CI	p	€	95% CI	p	€	95% CI	p
Gender									
Female vs. male	+1,648	61 to 3,236	.042	–357	–1,771 to 1057	.621	+1,724	782 to 2,666	<.001
Age									
Per year	–257	–359 to –155	<.001	–479	–580 to –378	<.001	+227	164 to 289	<.001
Marital status									
Widowed vs. married	+224	–1,577 to 2,025	.808	+268	–1,338 to 1,874	.744	+335	–739 to 1,408	.541
Divorced vs. married	–183	–3,263 to 2,896	.907	–1,607	–4,100 to 885	.206	+2,068	–102 to 4,239	.062
Never married vs. married	–22	–3,073 to 3,029	.989	–3,287	–5,485 to –1,088	.003	+4,376	1,926 to 6,827	<.001
Socio-economic status									
Per score point[a]	+763	–311 to 1,837	.164	+639	–318 to 1,597	.191	+209	–428 to 846	.520
Calendar time									
Per year	+185	38 to 332	.014	+39	–92 to 169	.562	+89	1 to 176	.048
Preceding health care expenses[b]									
Per €1000	+274	200 to 348	<.001	-	-	-	-	-	-
Preceding medical care expenses	-	-	-	+182	86 to 278	<.001	+45	0 to 98	.100
Preceding long-term care expenses	-	-	-	–434	–539 to –330	<.001	+759	653 to 866	<.001

Results for health care and medical care are from a generalized linear model with gamma distribution and a log link, and results for long-term care are from a two-part model with probit in the first part and GLM with gamma distribution and log link in the second part (n=2,844).

[a] Socio-economics score points range from 0 to 10.

[b] Preceding health care expenses are the expenses made in the 26th through 21st month before death.

The influence of age on expenses in the last six months before death and on average costs of the non-deceased are portrayed in figure 3. Panels on the left side show these expenses of different health services. Apparent from these panels is that expenses in the last six months before death rise with age for intramural long-term care (care homes, nursing homes, hospices, rehabilitation centres, and institutions for the handicapped). In contrast, expenses in the last six months before death for hospital, non-hospital and extramural long-term care lower with age. For the non-deceased group, medical care expenses remain rather constant with age. However, long-term care expenses increase rapidly with age: from a six months average of €475 for subjects aged 65 to 75 to €3,216 for subjects 85 years and older.

The influence of medical and long-term care expenses in the 26th through 21st month before death on expenses in both sectors in the last six months before death is portrayed in figure 4. Here, expenses in the 26th through 21st month before death in the medical care sector (left panel) and the long-term care sector (right panel) are divided into tertiles. The standardized expenses in the last six months before death in both sectors are given for each tertile with a 95% confidence interval. Made visible is that medical and long-term care expenses in the last six months before death increase when expenses in the 26th through 21st month before death increase in the medical care sector (left panel). Long-term care expenditure in the 26th through 21st month before death is also associated with higher long-term care expenses in the last six months before death, but with lower medical care expenses.

Discussion

There is not a large variation in the costs of dying of older people, but there are large differences in the nature of these costs. Mainly, the sum of expenses in the medical and long-term care sector is rather equally distributed, but there is a higher variation when the two sectors are taken separately. Main determinants of variation are age and preceding health care expenses. The costs of dying in medical care and extramural long-term care decrease with age, while the costs of dying in intramural long-term care increase with age. This implies that the younger share of older subjects spends more time at home or in the hospital before death, and the older share of subjects have a higher chance of receiving intramural care before death. The positive association between the costs of dying and preceding health care expenses imply that patients with more expenses at the end of life had a longer history of illness or disability.

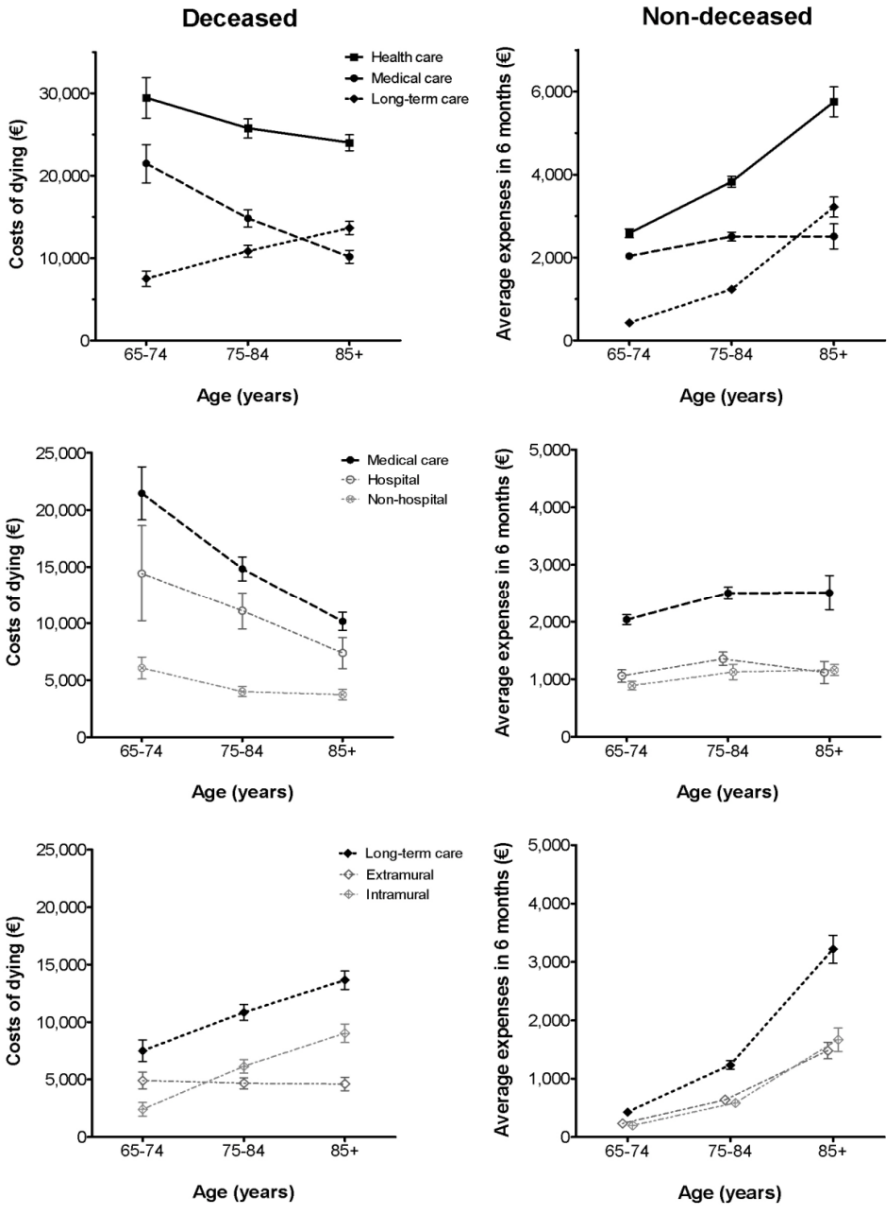

Figure 3. Age and health care expenses. In the left panels, the costs of dying (defined as the expenses in the last six months before death) are shown for different service types per age group. In the right panels, average health care expenses for six months of the non-deceased are shown. Expenses in both panels are standardized for socio-demographic characteristics and calendar time. Results are for 2,844 individuals in the deceased group and 42,204 in the non-deceased group. Note that the figures on hospital and non-hospital care are available for 926 and 12,996 subjects respectively (see methods section). Also note the differences in the y-axes.

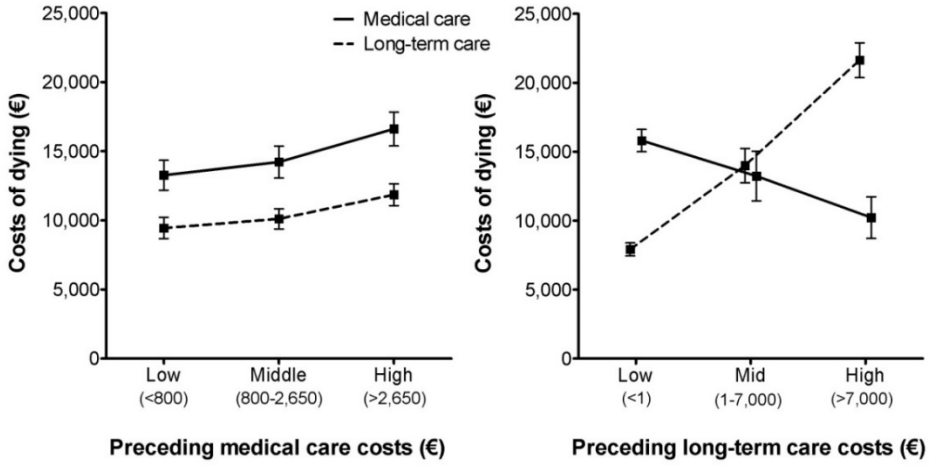

Figure 4. Preceding health care expenses and the costs of dying. The costs of dying are shown for medical care and long-term care (n=2,844), and are defined as the expenses in the last six months before death. Preceding medical and long-term care expenses are defined as the expenses in the 26th through 21st month before death. Costs of dying are standardized for socio-demographic characteristics and calendar time.

The finding that medical care expenses decrease with age for both decedents and survivors is consistent with the earlier findings that, with age, less costly illnesses become more common and treatment intensity decreases.[30-32] Another plausible explanation for decreasing medical care expenses with age is a substitution effect from long-term care. The risk of care home and nursing home admission increases with age, and basic forms of medical care provided in these institutions fall under the category long-term care through Dutch legislation. In other words, higher expenses in intramural long-term care automatically implies lower expenditure on medical care.

Where medical care expenses show a boom in the last two to three months before death, long-term care expenses grow more slowly before death. This longer run-up is in accordance with literature.[8,10,11,21] Expenses for hospital care, home care and nursing home make up two-thirds of the total costs of dying. Although spending on general practice and hospice care increase manifold with impending death, their shares in the total level remain very small (together 4.6%). The increase of expenses on general practitioners will likely be caused in part by their role in end-of-life decision-making in the Netherlands.[33] Results further show that higher preceding expenses are associated with higher expenses prior to death. It is plausible that preceding medical care expenses reveal previous or chronic health problems, which induce more expenses later in life

due to exacerbation of these illnesses or due to the occurrence of additional complications.[23] A similar dynamic may exist in the long-term care sector. Preceding expenses in this sector form a crude indicator for disability and/or frailty. It is therefore plausible that elderly with a history of disability and/or frailty have higher costs of dying in the long-term care sector.[13,34]

It is not unexpected that age is an important determinant for the costs of dying in long-term care, as a major part of the long-term care in the Netherlands is spent on elderly care for the oldest old. A plausible reason why older people without a partner have higher costs of dying is that informal care by partners substitutes for formal care.[20,22] Only age and preceding health care expenses seem to play a role in the variation in the medical care sector. In literature, the prevalence of disability, chronic illnesses and other health problems is reported to be higher in lower socio-economic groups than higher ones.[35] However, we could not find a significant influence of socio-economic status on the costs of dying in both sectors. It is possible that the socio-economic status indicator was too crude for regression purposes, as socio-economic status was not individually defined, but based on the average education level, income and capital of the postal code of each subject.

The relatively important role of calendar time on the costs of dying could for the most be explained by inflation and policy changes. The data shows that the effect of calendar time is most prevalent in long-term care. A similar trend is visible on the national level: the total level of long-term care expenditure has risen from 21.7 billion euros to 24.1 billion euros in the Netherlands between 2008 and 2010 (an 11% rise). It is also possible that, in some cases, long-term care utilization was not recorded properly before July 2007. Therefore, a few individuals may have used long-term care in the beginning of the study period, although this was not observed until a new coded message was issued in the EMEA Care Registration system. The threefold rise in long-term care expenditure of the non-deceased group in 26 months seen in figure 1 was explained by an increasing number of subject using long-term care, a change in care weight, and a rise in compensation per volume unit. These changes are partly caused by a two years increase in age (from 80 to 82 years) in the non-deceased group during these 26 months.

The goal of this study is to answer the question whether there are large differences in the costs of dying between individuals. We are the first to provide a comprehensive oversight of the factors causing variation, including preceding medical and long-term care expenses. Potential causes of variation other than socio-demographic factors and preceding expenses were not taken into account. Cause of death could be an additional explanatory variable concerning variation in the costs of dying. Also, levels

of social support through family-members and friends could influence long-term care expenses in general and late in life.[36,37] A plausible reason why deceased subjects who were never married make considerably more expenses in the last six months of life, is that many of them will not have children to provide informal care. However, the higher share of (mentally) disabled persons in the never married group will also have a profound impact on long-term care expenses.

There is a debate on the usefulness of time to death as a determinant of health care expenditure. A main objection is that proximity to death is only observable in retrospect, making forecasts on a micro-level impossible. On a macro-level, time to death is proposed to be useful only as a proxy for more appropriate determinants when these are not available, such as severe illness, disability, or frailty.[13] However, implications of our findings are useful for health policy-makers and clinicians involved in end-of-life care. Policy-makers need to consider the specific implications of population ageing on the health care system. Population ageing refers to three key points: (1) a rising life expectancy, (2) higher mortality rates, and (3) an increasing share of frail and disabled people. Higher mortality rates may increase health care expenditure, as costs rise steeply in the last months before death. However, the costs of dying decrease with age. This implies that rising life expectancy will dampen the cost-inducing effect of higher mortality rates. In the non-deceased group, medical care costs stay rather stable with age. Since per capita costs in intramural long-term care in the deceased and non-deceased rise steeply with age, it is possible that the demand for institutional long-term care will rise when both the number of frail elderly as well as life expectancy is increasing. However, it is also possible that demand will only be postponed, as healthy life expectancy is also increasing.

The share of hospital services is considerable in the costs of dying. It has been found, however, that higher costs of dying in the hospital are associated with a lower quality of death.[38] Consequently, further investigation is needed to find out if there is room for decreasing the costs of dying without sacrificing quality of life in the months before death. Results from a small number of studies suggest that end-of-life conversations and care-planning for older terminal patients can safely decrease expenditure levels in hospitals and nursing homes.[38-40] It is also possible that the marginal role of care from general practitioners and hospices can be expanded in the last months of life, but more research is needed on patient perspectives and (variation in) expenditure prior to death. Knowledge about these subjects will increase the understanding of ever increasing health care expenses and, more importantly, might contribute to the improvement of the quality of life close to death.

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Chapter 8

General discussion

Main findings

In this thesis, we investigated the determinants of mortality, health care expenditure (HCE), and the 'costs of dying' in the older population to gain a better understanding of how an ageing population affects HCE. We separated the determinants into two categories: (1) determinants that apply to the country as a whole (the macro-level); and (2) determinants that are relevant for individuals (micro-level). Chapters 2 through 4 relate to the macro-level: the national economy, seasonal changes, and national policy. Micro-level determinants – partner status, costs of dying, and individual tailoring of health care – are assessed in chapters 5 through 7.

Macroeconomic cycles and old age mortality

In **chapter 2** we analyse the association between gross domestic product and mortality in all citizens of middle and old age in 19 developed countries between 1950 and 2008. We find that mortality rates in both age groups increase during upward cycles in the economy, and decrease during downward cycles. The effect is stronger in men than in women. Similar results are found in a broad range of previously published studies performed for many different countries.[1-11] However, our analyses differs from these studies in several ways. First, we use cycles in gross domestic product rather short-term deviations in unemployment around cycles. We reason that cycles potentially capture more fundamental and long-lasting shifts in the economic environment of all citizens, while the annual deviations relate to sudden changes in the employment status of a relatively small part of the population.

Second, we specifically set out to compare a group of middle aged citizens with a group of older citizens. If changes in the economy affect people's health through changes in employment status or job stress – as is hypothesized by others[12] – one would expect to find a smaller association for the older, retired population. However, since the association is at least as strong for the older age group, this hypothesis needs to be revised or amended. We reason that older people might also show lifestyle improvements during downward cycles in the economy, and may receive more informal care from their children, who have a higher chance of becoming unemployed are receiving less working hours during a recession.

Seasonal changes

In **chapter 3** we assess whether the mortality risk, medical care expenses (MCE), and institutionalization risk of older people changes with the seasons. It has been shown that there is seasonal variation in mortality,[13-21] but seasonal variation in MCE and institutionalization risk has not been studied. As MCE rise exponentially before death, it is plausible that MCE shows seasonal variation *because* of seasonal variation in mortality. We therefore analysed whether there was seasonal variation in MCE separately from the possibly mediating effect of mortality, by dividing the study population in a deceased and survivor group.

We find that mortality rates and MCE of older people differ significantly between the seasons, and are higher in the winter and autumn compared to spring and summer. Institutionalization rates are significantly higher in the winter, but the other seasons show no significant impact. The changes in mortality risk and MCE show that older people's health is affected by the seasons. Results from previous studies suggest that temperature and flu prevalence could play a pivotal role in these seasonal changes. However, we find that the mortality rates of institutionalized elderly also change with the seasons, which implies that season-dependent outside temperature cannot solely explain seasonal variations found in this study.

Gatekeeping

After analysing the impact of the economic and seasonal environment on older people's health and related expenses, we focused on the possible influence of the health care system in **chapter 4**. In this chapter, we analyse whether utilization of care from general practitioners affects expenses for other health care services later in time. First, we hypothesize that GP expenditure is inversely associated with expenses for other health care services later in time in a population of older people, because GPs prevent overutilization of specialist care through watchful waiting, and the provision of basic treatments at lower costs. Adjusting for morbidity is crucial. However, because we could not acquire data on specific diagnosis codes of individuals due to privacy concerns, we try to adjust for morbidity to the best of our ability by using different determinants in our statistical analysis, viz. baseline health care consumption, socio-demographic characteristics, mortality and time variables.

The analysis shows that GP expenditure is positively correlated with expenses for other health care services later in time: for every €10 spent on GPs, expenses for other health care services later in time increase with €74 ($p<.001$). The positive association can be explained by three dynamics: (1) expenses for GPs are automatically associated with expenses for other health care services because patients often receive or

even require a referral from the GP before receiving specialist health care; (2) GPs could increase the overall level of HCE by improper diagnoses or unnecessary referrals; (3) our statistical methods did not adequately account for the likelihood that patients who have more health problems visit GPs *and* other health care providers more frequently.

A transitional care programme

Similar to the latter chapter, **chapter 5** also focused on the impact a health system can have on the HCE of older people. In contrast to chapter 4 however, we focus here on an implementable small-scale care programme directed at individually tailoring health care for older people with multi-morbidity, rather than on an existing national health care policy. The programme consists of four major components: (1) risk assessment of frail older people; (2) an integrated multidisciplinary care structure to improve the care pathway; (3) improved follow-up of care; and (4) optimization of transition of care. The cohort in the transitional care programme is compared to a cohort with non-participation from an earlier period in time.

Pre/post evaluations show an improvement in outcomes for frail older hospitalised patients through co-creation of a transitional care programme: compared to the first cohort, patients in the second cohort suffered less adverse outcomes, while long-term care expenditure except for rehabilitation remained the same. These results thus suggest that a transitional care programme, as described above, can improve the health of frail, older people. The first cohort was assessed in 2010 and 2011, while the second cohort was assessed in 2012 and 2013. Between these two time frames, other policy changes could have had a considerable effect on the outcomes as well.

The loss of the spouse

In **chapter 6** we focus on an important determinant of an older individual's HCE: partner status. More specifically, here we aim to study HCE in the months before and after the loss of the spouse while adjusting for socio-demographic characteristics and calendar time. Previous research shows that the loss of the spouse by an older person increases the risk of nursing home admission,[22-26] and has a detrimental effect on the health of the recently widowed.[27-29] It would therefore be plausible that health care costs also rise after the death of the spouse. However, health care costs could also rise because, with the loss of the spouse, an older individual will have lost his or her most important informal caregiver, and will now need to acquire care from the formal care sector.

We found that, on average, health care costs increases with €239 per month (+48%) after the death of the spouse. Overall, the rise sets in at the month someone

becomes widowed and remains at this level for at least 3½ years. The rise in health care costs is highest for men (+59%) and the oldest old (+82%). The relative increase in long-term care expenditure after the loss of the spouse is five times higher in the long-term care sector than in the medical care sector. For this reason, and also because there is no temporary peak after the death of the spouse, which would be consistent with a bereavement effect, it is plausible that this sudden but sustained rise in health care costs is – for a large part – attributable to the loss of an important informal caregiver.

The costs of dying

There is a large body of research on the association between proximity to death and HCE.[30-41] However, in **chapter 7** we focus on a question that remained unanswered in this research area: what is the variation in the 'costs of dying'? Besides socio-demographic variables and calendar time, which we include in the analyses of previous chapters, we also include preceding health care expenses in our analysis. We hypothesize that patients with a longer history of illness or disability would have lower costs of dying than those without such a history, because death might be more anticipated.

We found that the variation in the costs of dying of older people is small, and that, in accordance with literature, the costs of dying become lower with increasing age. However, there are large differences in the nature of expenditure at the end of life: when the costs of dying are separated in medical and long-term care expenditure there is a large variation within each of the two sectors. This variation is mainly caused by age: costs of dying of the oldest old pertain mainly to long-term care expenditure, while the costs of dying of their younger counterparts pertain mainly to MCE. Main determinants of variation in the costs of dying are age and preceding health care expenses. The latter implies that patients with more costs at the end of life had a longer history of illness or disability.

Implications

As was outlined in the introduction, the term population ageing refers to three dynamics: (1) rising life expectancy; (2) a higher share of people of advanced age; and (3) increased mortality rates. These three dynamics will be discussed here, incorporating the results of the former chapters. The limitations of the analyses reported in this thesis will be described thereafter.

Rising life expectancy

Life expectancy is continuously on the rise in developed countries.[42-44] Whether a rising life expectancy will increase or dampen health care costs depends on the trajectory of *healthy* life expectancy. If the increase in healthy life expectancy will lag behind the increase in life expectancy – or if healthy life expectancy will even decrease – the average number of life years spent in ill health per individual will increase, and, consequently, health care costs will rise.

It was found that healthy life expectancy lagged behind life expectancy in 187 countries between 1990 and 2010: worldwide, life expectancy at birth increased with 4.7 for men and 5.1 for women, while healthy life expectancy increased with 4.2 for men and 4.5 for women.[45] This implies that the gap between life expectancy and healthy life expectancy grows with ~0.03 per year; a small increase, of which the impact on HCE is unknown.

In the Netherlands, both disability-free life expectancy and life expectancy in good self-reported health did not lag behind life expectancy between 1985 and 2010.[46-48] However, remarkably, life expectancy without chronic disease *decreased* in this time period. This does not imply that the health of individuals deteriorated, but this downturn can be, in part, explained by an earlier detection and treatment of chronic diseases due to advances in medical knowledge and technology. However, it has been established that earlier detection and medical advances do not provide the full picture, and that the prevalence of chronic diseases – like diabetes and atrial fibrillation – has increased in recent decades.[49,50] This increasing prevalence can be traced back to changes in lifestyle, but also to an increasing share of older people (see next paragraph). All in all then, healthy life expectancy shows a marginal lag behind life expectancy, and an important part relates to changes in lifestyle, and not demographic changes.

If we then shift the focus from healthy life expectancy to life expectancy, we can see that a rising life expectancy may even have a dampening effect on HCE. We found that the costs of dying in the medical care sector decreases with age, and that MCE unrelated to death remain rather stable with age. Although the costs of dying in the long-term care sector do increase with age, the total costs of dying (medical and long-term care) still decrease with age. To summarize then, it is plausible that an increasing life expectancy will have the following consequences: (1) the average costs of dying in society will decrease, (2) the level of MCE unrelated to death will remain rather stable, and (3) long-term care expenditure (LTCE) might also remain stable as, with an increasing life expectancy, the onset of disability and frailty will be postponed – as opposed to the idea that people will live longer with disability and frailty.

Higher share of older people

Although MCE does not increase with age, LTCE does. Consequently, an increasing share of older people will predominantly affect LTCE, and will have no or little effect on MCE. However, fundamental changes in the long-term care sector in many countries could partly prevent such a rise in LTCE. In the Netherlands, the long-term care act is currently downsized: the responsibility of extramural long-term care is gradually transferred to municipalities through the Social Support Act, and their limited budgets will cause heavy cutbacks in extramural long-term care. Also, more strict inclusion criteria for intramural care will further decrease LTCE.

Second, results from previous literature suggests there is a substitution effect between informal and formal care.[51-56] When increasingly fewer elderly are eligible for long-term care, it is to be expected that informal care will become more prevalent in the future. Also, additional efforts by policy-makers to stimulate informal care may further reduce levels of LTCE. It would be wise for policy-makers to better promote and facilitate informal care in times of economic expansions, as it is possible that informal care attenuates during good economic times, and rekindles during economic downturns (see chapter 2).

Third, we find that older people have a fivefold increase in LTCE when they lose their spouse, which further corroborates the substitution effect between formal and informal care described above. As the life expectancy of men is rising faster than that of women, it is plausible that the number of widows will decrease in the future. This will then have a dampening effect on the average individual level of HCE, and especially LTCE.

Fourth, a large share of older people – especially the oldest old – suffer from multiple chronic diseases. Multi-morbidity places a high burden on the health care system and expenses. However, initiatives such as the transitional care programme described in this thesis (chapter 5), can potentially improve the quality of life of older people. Similar initiatives may provide more efficient means to improve the coordination and provision of care for patients suffering from multi-morbidity and frailty.

Higher number of deaths

Over the course of decades, even centuries, advances in economic welfare, nutrition, public health, and medicine have contributed to a reduction in mortality – and therefore an increase in life expectancy – in most regions in the world.[57-59] In accordance with literature,[32,37,41,60] we find that MCE at the end of life decrease with age at death – with approximately 3% per year (see chapter 6). Also in accordance with literature,[38] we find that LTCE at the end of life increases. However, we are the first to find that total HCE

(i.e., the sum of MCE and LTCE) decrease with age (~1% per year). This implies that an increase in life expectancy will lead to a *decrease* in the average costs of dying. In conclusion, as the total number of deaths will increase due to population ageing, the level of costs associated with the end of life will also increase. However, it is unclear how much a rising mean age at death will offset this trend.

Strengths and weaknesses, implications for future research

We had access to different extensive datasets to make the studies presented in this thesis possible, including data from Statistics Netherlands, a regional health care insurer, the Human Mortality Database, the Angus Maddison dataset on historical economic indicators, and the Netherlands Institute for Social Research. We believe these rich datasets provide the backbone of our results, and form a major strength of this thesis.

Unfortunately, specific forms of useful data could not be collected. This was especially the case for chapter 4, where we analysed the association between baseline expenses for GPs and expenses for other health care services to clarify the impact GP gatekeeping could potentially have on HCE. Due to privacy concerns, we could not collect or construct data that was crucial to adjust for confounding in the form of morbidity. The statistical mechanisms we exercise could probably not adequately capture a good indicator for morbidity. We strongly advise researchers to establish a solid and specific indicator for morbidity for future research. Further research is necessary, as the GP could play a pivotal role in making the health care system more sturdy and efficient in dealing with population ageing.

In another example, data on seasonality reflected monthly estimates in a relatively short period of time (3½ years). Ideally, daily estimates of disease incidence rates, mortality rates (by cause of death), MCE, and institutionalizations in combination with daily data on temperature, sunlight hours, atmospheric pressure, flu prevalence, and air pollution could have revealed much more information on the intricate and multi-faceted association between the seasons and health, HCE, and mortality.

For future research on the association between the economic environment and old age mortality, we would encourage researchers to use macro- or observational data to further specify *who* suffers during economic changes, and *why*. Do the unemployed show more risky and violent behaviour, such as addiction, suicide and homicide? And do those who remain employed show an improvement in lifestyle? And last but not least, do those with less working hours during economic crises find more time to spend with their parents or other older relatives, possibly in the form of informal care?

Final conclusion

Population ageing affects health care expenditure through a myriad of dynamics which can be categorized in three major components: rising longevity, a higher share of older people, and increasing mortality rates in combination with high 'costs of dying'. By disentangling these dynamics, and relating the insights presented in this thesis on the determinants of old age mortality, health care expenditure, and the costs of dying, we have shown that the effect of population ageing on health care expenditure may be curtailed by different trends.

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Nederlandse samenvatting

Vergrijzing en zorguitgaven

Inleiding

Veel landen staan op de drempel van een belangrijke demografische verschuiving. Deze verschuiving in leeftijdsopbouw wordt in Nederland vaak 'vergrijzing' genoemd. De term vergrijzing wordt vooral geassocieerd met een toename van het aantal ouderen, die zal leiden tot een hogere druk op de collectieve financiën, vooral door een hogere vraag naar medische en langdurige zorg. Uit economische studies blijkt echter dat demografische verschuivingen een marginale invloed hebben op de stijgende zorguitgaven; in vergelijking hebben medische ontwikkelingen, een achteruitgang in de efficiëntie van arbeid en herstructurering van de zorg een veel grotere impact.[1-3]

Om de implicaties van de genoemde demografische verschuiving in zijn geheel te begrijpen moeten drie separate 'dynamieken' van de vergrijzing onderkend worden: (1) een hogere levensverwachting; (2) een groeiend aandeel ouderen in de algehele populatie; (3) een hoger gemiddeld sterfterisico in de algehele populatie. In dit proefschrift richten we onze aandacht op verschillende factoren die deze dynamieken beïnvloeden, variërend van klimaatfactoren tot de individuele levensloop.

Voor ons onderzoek hebben we gebruik kunnen maken van verschillende *databases.* Door data van een zorgverzekeraar en het Sociaal Cultureel Planbureau te koppelen aan data van het Centraal Bureau voor de Statistiek hebben we inzicht gekregen in de socio-demografische kenmerken en individuele zorgkosten van 61.495 ouderen in de regio van Leiden. Deze data zijn gebruikt voor hoofdstuk 3 t/m 7. Voor hoofdstuk 2 hebben we gebruik gemaakt van publiekelijk beschikbare data van Angus Maddison (historische data van landelijke welvaartscijfers) en de *Human Mortality Database* (historische data van landelijke sterftecijfers).

Overzicht van het proefschrift

Deel I van dit proefschrift bevat drie hoofdstukken (hoofdstuk 2 t/m 4) waarin enkele 'macro-niveau' factoren worden behandeld die de sterftekans en zorguitgaven van ouderen kunnen beïnvloeden. In **hoofdstuk 2** onderzoeken we welke impact 'macro-economische cycli' – oftewel langdurige conjunctuurgolven – kunnen hebben op de sterftekans van mensen op middelbare en oudere leeftijd. Eerdere studies over dit onderwerp geven een tegen-intuïtieve boodschap: economische groei en afnemende werkloosheid worden geassocieerd met een *toename* van het aantal doden in de populaties van ontwikkelde landen.[4-14] De centrale theorie achter deze bevinding is dat toenemende werkstress tijdens economische groei gepaard gaat met gezondheidsrisico's, die vervolgens kunnen leiden tot de dood. Uit ons onderzoek blijkt echter dat de sterftekans

onder ouderen minstens zo gevoelig is voor conjunctuurgolven als die van mensen van middelbare leeftijd. Dit betekent dat werkstress óf niet de juiste verklaring is, óf niet de enige verklaring kan zijn. Mogelijk leiden – ten tijde van hoogconjunctuur – drukkere wegen tot meer verkeersdoden en hogere industriële activiteit tot meer ziektegevallen door luchtvervuiling. Ook is het mogelijk dat een hogere werkdruk onder werkenden leidt tot een afname in de mantelzorg die geboden wordt aan ouderen – wellicht is mantelzorg van groot belang voor de gezondheid van ouderen.

In **hoofdstuk 3** verschuiven we de aandacht van het economische klimaat naar het eigenlijke klimaat. Eerder onderzoek naar de invloed van jaargetijden op sterftekans laat zien dat de sterftekans op populatieniveau toeneemt als de temperatuur afneemt, maar ook dat excessieve warmte kan leiden tot sterfte.[15-23] Het is onbekend of de seizoenen invloed hebben op medische zorgkosten of institutionalisering (de opname in verzorgings- of verpleeghuizen). Ons onderzoek bevestigt dat er in Nederland meer oudere mensen sterven tijdens de koude seizoenen (herfst en winter) dan tijdens de warme seizoenen (lente en zomer). De medische zorgkosten laten dezelfde seizoensvariatie zien; institutionalisering piekt alleen in de winter. Een eerste conclusie zou kunnen zijn dat het logisch is dat er seizoensvariatie in medische zorgkosten wordt gevonden, aangezien de medische zorgkosten exponentieel stijgen voor dood (zie hoofdstuk 7) en de dood vaker intreedt tijdens de koude seizoenen. Echter, wij constateren dat de seizoensvariatie in medische zorgkosten zelfs sterker is onder ouderen die nog een lange(re) levensverwachting hebben. Factoren die seizoensvariatie in sterfte en medische zorgkosten kunnen verklaren zijn: koude temperaturen, griepepidemieën, gladde wegen en stoepen, maar ook veranderingen in zonlichturen, luchtdruk en luchtvervuiling. Hoe deze mogelijke oorzaken zich tot elkaar verhouden is onbekend. Echter, aangezien we vinden dat de sterftecijfers van ouderen in verzorgings- en verpleeghuizen – waarbinnen een constante, kunstmatige temperatuur heerst – ook seizoensvariatie laten zien, kan temperatuur niet de belangrijkste reden zijn.

In **hoofdstuk 4** – het laatste hoofdstuk van deel I – richten we de aandacht op het landelijke zorgstelsel. We onderzoeken hier de bewering dat een sterke 1e lijnszorg potentie heeft om de volksgezondheid te bevorderen en de zorgkosten kan verlagen; vooral omdat de huisarts een rol als poortwachter vervult en daarmee kan voorkomen dat patiënten onnodig dure specialistische zorg ontvangen. Daarnaast kan de huisarts basale ingrepen of interventies verrichten tegen een lagere kostprijs. Met dit uitgangspunt analyseren wij of ouderen die meer zorg ontvangen van de huisarts minder kosten maken in de 2e of 3e lijnszorg. Uit deze studie blijkt dat zorgkosten bij de huisarts positief gecorreleerd zijn aan overige zorgkosten later in de tijd. Met andere woorden, ouderen die meer kosten maken bij de huisarts maken later ook meer kosten in andere

zorgsectoren. De gedachte dat huisartsen dure specialistische zorg voorkomen is hiermee dus niet bekrachtigd. Echter, we kunnen maar beperkt corrigeren voor morbiditeit. Het is dan ook zeer waarschijnlijk dat de positieve correlatie voortkomt uit het feit dat zieke ouderen simpelweg meer zorgkosten maken in alle zorgsectoren.

In deel II van dit proefschrift vernauwen we de focus en richten we ons op de factoren op 'micro-niveau' die invloed hebben op de zorguitgaven en sterftekans van ouderen. In **hoofdstuk 5** analyseren we de effectiviteit en uitgaven van een kleinschalig zorgprogramma dat gericht is op het individueel toespitsen van zorgactiviteiten voor ouderen met multi-morbiditeit. Onze conclusie is dat voor ouderen die aan dit zogenaamde Herstelzorgprogramma deelnamen de uitkomsten beter waren dan voor ouderen die standaard zorg ontvingen, terwijl de langdurige zorguitgaven van beide groepen gelijk bleven. Belangrijke verbeterpunten die werden gerealiseerd in het Herstelzorgprogramma zijn: aangepast risicomanagement; een geïntegreerd en multidisciplinair zorgpad gericht op behoud van functie; optimalisering van communicatie en overdrachten tussen verschillende zorginstellingen; en specifieke geriatrische interventies.

In **hoofdstuk 6** verschuiven we de focus van de formele zorg die een patiënt omringt naar de informele zorg. We onderzoeken hier of het verliezen van de belangrijkste mantelzorger (de partner) impact heeft op de zorguitgaven van een ouder individu. We vinden dat de zorguitgaven van een oudere met ongeveer 50% toenemen in de maand dat hij of zij de partner verliest; deze verhoging houdt minstens 3½ jaar aan (zo ver reikt de studieperiode). De toename is sterker voor mannen en oudere mannen én vrouwen van 80 jaar of ouder. Omdat de stijging van zorguitgaven het grootst is binnen de langdurige zorg en omdat er geen echte piek waarneembaar is na het verliezen van een partner, is het waarschijnlijk dat het effect op de zorguitgaven vooral veroorzaakt wordt door het permanente verlies van een mantelzorger en minder door rouw.

In **hoofdstuk 7** – het laatste hoofdstuk van deel II – richten we de aandacht op de 'kosten van het doodgaan'. Het is bekend dat de zorguitgaven van een individu exponentieel stijgen voor zijn of haar dood.[24-34] Wij onderzoeken of er veel variatie bestaat in de zogeheten kosten van het doodgaan en, zo ja, waar die variatie vooral door verklaard kan worden. Wanneer we de medische en langdurige zorg samenvoegen, is er weinig variatie in de kosten van het doodgaan. Echter, binnen de sectoren zelf is wel variatie waarneembaar. Deze variatie wordt vooral verklaard door leeftijd: de medische zorguitgaven voor de dood dalen met de leeftijd terwijl de langdurige zorguitgaven voor de dood stijgen met de leeftijd. Zorguitgaven uit het verleden hebben ook invloed op de hoogte van de kosten van het doodgaan. Ouderen die 2 jaar voor hun dood relatief hoge zorguitgaven hebben, hebben ook meer zorguitgaven vlak voor de dood. Dit impliceert dat een geschiedenis van ziekte gepaard gaat met hogere kosten van het doodgaan.

Discussie

Zoals in de inleiding van deze samenvatting te lezen is, valt de term vergrijzing onder te verdelen in drie 'dynamieken': (1) een hogere levensverwachting; (2) een groeiend aandeel ouderen; (3) een hoger gemiddeld sterfterisico in de algehele populatie. Van de vele factoren die van invloed zijn op de zorguitgaven van ouderen, hebben we in dit proefschrift enkelen behandeld. De vraag die we nu behandelen is: Hoe hebben de in dit proefschrift behandelde factoren invloed op de drie dynamieken?

Levensverwachting

De levensverwachting is continu stijgende in ontwikkelde landen. Wat de invloed van deze toenemende levensverwachting is op de zorguitgaven van ouderen, is afhankelijk van hoe de gezonde levensverwachting zich zal ontwikkelen. Als de gezonde levensverwachting net zo snel stijgt als de levensverwachting, dan zal, per individu, het aantal levensjaren in minder goede gezondheid gelijk blijven in de toekomst. Dit betekent vervolgens dat er geen 'expansie' van zorguitgaven over de individuele levensloop zal plaatsvinden. Echter, als de stijging van de gezonde levensverwachting minder snel stijgt dan de levensverwachting, dan zullen de gemiddelde individuele zorguitgaven wél stijgen.

Tussen 1985 en 2010 is in Nederland de 'levensverwachting zonder beperkingen', als ook de 'levensverwachting in goede zelf-ervaren gezondheid', gelijk opgegaan met de levensverwachting.[35] Echter, de 'levensverwachting zonder chronische ziekte' is gedaald in deze periode. Let wel, dit betekent niet dat daadwerkelijke gezondheid van Nederlanders is achteruitgegaan; waarschijnlijk heeft een betere diagnostisering en behandeling van chronische ziektes een belangrijk aandeel in de daling van deze vorm van levensverwachting. Echter, de prevalentie van sommige chronische ziektes – zoals diabetes of atriumfibrilleren – is wel toegenomen in de afgelopen decennia, wat vooral te verklaren is door een verslechtering van leefstijl en wellicht ook door een toename van het aantal ouderen, die meer ontvankelijk zijn voor dergelijke chronische ziektes.

Stijgend aandeel ouderen

De zorguitgaven stijgen in een samenleving als het aandeel ouderen toeneemt. Dat komt omdat, op individueel niveau, de zorguitgaven stijgen met het toenemen van de leeftijd. Er zijn echter verschillende ontwikkelingen gaande die de impact van een groter aandeel ouderen op de zorguitgaven kunnen dempen. Ten eerste zien we dat de medische zorguitgaven tijdens de levensloop van een individu gemiddeld genomen ongeveer constant blijven. De langdurige zorgkosten, daarentegen, stijgen wel met de leeftijd. Op het

moment van schrijven vinden er in Nederland belangrijke beleidswijzigingen plaats – zoals de overheveling van bepaalde langdurige zorg van de AWBZ naar de WMO – die gepaard gaan met bezuinigingen. Ten tweede zien we dat ouderen na het verliezen van een partner een vijfvoudige toename in langdurige zorguitgaven hebben. Omdat de levensverwachting van mannen sneller stijgt dan die van vrouwen, zal het aantal weduwes in de toekomst afnemen. Dit gegeven zal de druk op de langdurige zorg verminderen. Ten derde vinden er initiatieven plaats die de langdurige zorg in Nederland efficienter of effectiever kunnen maken. Hiervan is het Herstelzorgprogramma, besproken in dit proefschrift, één voorbeeld.

Hoger gemiddeld sterfterisico

Zoals eerder is genoemd, stijgen de individuele zorguitgaven exponentieel voor de dood. Het aandeel van de zorguitgaven in de laatste maanden van het leven maken hierdoor een aanzienlijk deel uit van het totale niveau aan zorguitgaven. Door de eeuwen heen hebben toenemende welvaart en betere zorg, voeding en hygiëne ervoor gezorgd dat de sterftekans is gedaald, waardoor de levensverwachting is gestegen. Aangezien de 'kosten van het doodgaan' dalen met de leeftijd, zal het toenemend aantal sterfgevallen tijdens de vergrijzing dus deels gecompenseerd worden door een andere component van de vergrijzing: een toenemende levensverwachting.

Toekomstig onderzoek

Het belang en de mogelijkheden van verder onderzoek zijn groot. Het zal van grote waarde zijn om te kijken naar de invloeden van verschillende indicatoren van de economische omgeving en het klimaat op verscheidene subgroepen. Daar kan dan uit gededuceerd worden wat de proportionele invloed is van gewerkte uren, werkloosheid, ontvangen mantelzorg, verkeersvolume, luchtvervuiling, temperatuur, zonlichturen, enzovoorts, op de gezondheid en zorguitgaven van ouderen. Het is van belang om naar subgroepen te kijken, omdat we alleen dan kunnen achterhalen of sommige groepen – zoals alleenstaande ouderen van zeer hoge leeftijd, of werkloze mensen van middelbare leeftijd – vooral te lijden hebben onder bepaalde omstandigheden. Beleid zal zich dan moeten toespitsen op deze groepen als deze omstandigheden zich voordoen. Het is verder van specifiek belang voor beleidsmakers om te achterhalen wat het aandeel is van de naderende dood van een oudere, of dat van zijn of haar partner, in het totale niveau van de individuele zorguitgaven. Vervolgens zal nagedacht moeten worden over welke beleidsmaatregelen zullen helpen om deze uitgaven te verminderen zonder dat dit ten koste gaat van de kwaliteit van leven van ouderen.

Conclusie

Alhoewel de vergrijzing gepaard zal gaan met een toename in de zorguitgaven is de impact van de vergrijzing beperkt in vergelijking met die van andere ontwikkelingen. Als we de bevindingen van dit proefschrift samenvoegen, kunnen we concluderen dat de impact van de vergrijzing waarschijnlijk nog 'gedempt' zal worden, met name door de toenemende levensverwachting (vooral van mannen) en de mogelijkheid om met interventies de efficiëntie van ouderenzorg te verbeteren.

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Appendix

List of publications
Acknowledgements
Curriculum vitae

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Curriculum vitae

Hendrik Jan Albert (Herbert) Rolden was born on the 2nd of August 1983 in Groningen, the Netherlands, and raised in Bedum. He attended the Reitdiep College (formerly Kamerlingh Onnes) in Groningen from 1995 to 2001. Hereafter, he studied Economics at the University of Groningen where he attained his Master's degree in 2006 – quickly followed with a bachelor's degree in Philosophy of the Social Sciences at the same university. After a bit of traveling and working (including an internship at Trouw, a national newspaper) he finished his Master in Philosophy in 2010. In the same year he started his PhD at the Leyden Academy on Vitality and Ageing. In the first year of his PhD, he attained a Master's degree in Vitality and Ageing. Hereafter, he organized the courses 'philosophy' and 'governance' for the same Master, together with David van Bodegom, and provided several lectures, mainly related to philosophy and the structure and financing of health care. In 2012 and 2013, he published two reports on the Dutch health care system, together with Marieke van der Waal, and he presented these reports in Tokyo in 2013. In 2014, he started working as a postdoctoral researcher at the Radboudumc in Nijmegen. Here, he is investigating the ethical limitations of including vulnerable patients in clinical trials.