Hospital and long-term care use according to age and proximity to death in Finland: variations by cause of death and socio-demographic position

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Abstract

Background: With rapid population aging, provision of hospital and long-term institutional care services for the growing number of older people is a major policy concern. We estimate use of hospital and long-term care by age and proximity to death for selected causes and by gender, education and marital status.

Methods: A 40 % random sample of the Finnish population aged 65 and older at the end of 1997 drawn from population registers with information on socio-demographic factors at baseline was followed to death by cause in 1998–2002 or to the end of 2002. The use of hospital and long-term institutional care was assessed in 1995–2002 up to seven years prior to death or end of follow-up.

Results: Use of both hospital and long-term care increases rapidly with age, while proximity to death is more important for hospital care. We observe modest differentials in average care days in the previous seven years according to education, but the married use both hospital and long-term care less than the non-married. Care use of those dying from dementia is approximately twice that for other causes considered and is substantial for an extended period before death, while care associated with malignant neoplasms in more concentrated in the last year of life.

Conclusions: With later average age at death future need for hospital and particularly long-term care is likely to increase substantially. Accounting for proximity to death in care projections is likely to reduce some of the pressures in hospital care, but less so for long-term care. Anticipated changes in marital status distributions among the elderly are likely to alleviate long-term care needs but only among women, while the rapid increase in numbers with dementia is likely to increase the demand for both long-term and hospital care.

Introduction

One of the major concerns relating to population ageing is the provision and financing of health and long-term care services for the growing number of older people and especially the 'old old'. Although the average cost and use of hospital care services rises substantially with age, it is argued that the real reason for this is not to do with age *per se*, but with the fact that at older ages, more people are close to death. A typical finding in the US and elsewhere is that about one third of a person's total lifetime use of hospital care services takes place in the last two years of life (Hoover *et al.*, 2002; Wanless, 2001).

The implications of whether health care needs are affected more by proximity to death than by age are substantial. If health care use is heavily determined by experiences shortly before death, then expected costs of population aging are likely to be less than if care use is mainly determined by old age. These cost savings may be brought about in two ways. Firstly, pushing out the age at death in populations with increasing life-expectancy reduces the number of deaths occurring in a given year (Murphy and Martikainen, 2010, forthcoming), and secondly the health care costs in the last years of life tend to be lower for people who die at older rather than at younger ages (Brockmann, 2002).

Little is known about the relationship of long-term care costs with age and proximity to death. However, existing evidence suggests that although the use and costs of both nursing and social care rise with age, proximity to death is much less important for nursing care than for acute medical care (Spillman and Lubitz, 2000; Yang et al., 2003, McGrail *et al.*, 2000, Häkkinen et al., 2008; Forma et al., 2009).

Care use is of course not only determined by age, and proximity to death, but also by other socio-demographic factors. Gender, education and marital status are of central importance because all are well established determinants of health, hospital care and long-term care use. Educational differences in health and mortality are one of the most consistent findings in epidemiology (Mackenbach et al. 2008) and education is likely to influence care use both indirectly, through its effect on health status, as well as more directly for example through care seeking behavior or ability to purchase health services. Being single, widowed or divorced is also associated with poorer health and higher costs of medical care than being married (Seshamania and Gray, 2004). It is well-recognized that those living with a partner are less likely to enter and stay in long-term care than those living alone (Martikainen et al, 2009), at least partially because of greater availability of informal care. Finally, different underlying health problems and causes of death may be associated differently with end of life care and functioning. Gradual decline in functioning has been shown to be associated with dying from chronic diseases and a more abrupt decline for advanced cancer (Lunney et al., 2003; Chen et al., 2007). In particular, strong need for hospital and long-term care during an extended period before death could be assumed for conditions associated with severe functional decline – in particular dementia (Chen et al. 2007). To our knowledge none of the previous studies on age and proximity to death on hospital and long-term care have been able to incorporate information on both socio-demographic factors and cause of death. Furthermore, most analyses are limited to relatively short periods, typically 1–2 years, before death.

Few countries have good data on joint use of hospital and long-term care facilities that allow for inclusion of information on cause of death and socio-demographic characteristics. However, Finland has good integrated longitudinal record systems based on linkages of relevant registers with virtually

non-existent loss to follow-up (Häkkinen *et al.* 2008). Using these large registration based data sources, the current study extends previous work with in-depth analyses of the effects of age and proximity to death on hospital and long-term care for selected groups of causes of death. The results are presented separately by gender as well as education and marital status as these factors are likely to be associated with care needs.

Design and methods

Sample

The data used for these analyses consisted of a 40% random sample of the Finnish population aged 65 and older at the end of 1997 drawn from the population register. Statistics Finland provided data on socio-demographic characteristics in 1997 and dates and causes of death in 1998-2002, and the Research and Development Centre for Welfare and Health (STAKES) provided data on entry to and exit from long-term institutional care and hospital care in 1995-2002. Statistics Finland linked these data together using personal identification codes (permission TK 53-576-04). The data comprised altogether 301 263 persons of whom 73 451 died during follow-up.

Definitions of long-term institutional care, hospital care and days spent in care

Days in long-term care included days spent in nursing homes, service homes with 24-hour assistance, and rehabilitation care. Hospital care referred to days spent in either a hospital or a health center, and included both overnight stays and day surgery. In its overall structure the Finnish health care system is closest to those of other Nordic countries and the UK, in that it covers the whole population and its services are mainly provided by the public sector and financed mainly through general taxation.

Information on care use was based on institutional discharge registers and end of the year patient censuses. Using data on entry and exit dates we identified 1 909 746 care episodes spent in either long-term or hospital care. The exact exit date was not available for about 5% of all care episodes. In these cases the exit date was set to the date of the last patient census at which the person had been present. This is likely to somewhat underestimate the days spent in care. However, the bias is likely to be small, because most of the episodes with missing exit dates were overlapping with or immediately followed by other care episodes.

Marital status, education and age

Marital status and educational information from the end of year 1997 were used throughout the analysis. Marital status at baseline was categorized as: (1) married (2) non-married. The two educational categories were based on the highest educational qualification: (1) higher or intermediate, and (2) basic education. Age at death or end of follow-up was used as a continuous variable in single years.

Cause of death

We categorized deaths according to the underlying cause of death recorded on the death certificate using the International Statistical Classification of Diseases, 10th Revision. The following categories were identified: ischaemic heart diseases (I20–I25), cerebrovascular diseases (I60–I69), other diseases of the circulatory system (I00–I15, I26–I28, I70–I99), dementia and Alzheimer's disease (F01, F03, G30, R54), malignant neoplasms (C00–C97), diseases of the respiratory system (J00–J64, J66–J99), other diseases, and accidents and violence (V01–X44, X46–Y89).

Statistical methods

We used growth curve models to analyze the number of days spent in long-term and hospital care each year preceding death or end of follow-up. To achieve this we assessed the care status for each participant for each single day (when alive) during the study period as either (1) at home, (2) in long-term care, (3) in hospital care. If a person had overlapping days of long-term care and hospital care (altogether 1.4 per cent of all care days), we gave priority to hospital care. We then aggregated these care data for successive 365-day periods before the day of death for the deceased and before the end of follow-up (31.12.2002) for the survivors.

Age-adjusted growth curve models were set up to compare care use patterns among those deceased at a particular age to those surviving to the same age at the end of the follow-up; e.g. we compared deceased 75 year-olds to survivors aged 75 at the end of follow-up. The analyses ignored secular trends in care use. A growth curve model uses repeated measurements of the dependent variable to plot trajectories of the measure as a function of time (years before death or end of follow-up in our study). These models are formally described as multilevel models with each year at level 1 nested within people at level 2. The form of the growth curve was not preset. Accordingly, the predictor variable year before death or end of follow-up was included in the analysis as a categorical variable. Age, gender, marital status and education variables constituted the fixed effects part of the model, while only the coefficients of year before death or end of follow-up were allowed to vary randomly between subjects (Rabe-Hesketh & Skrondal 2008). In the presentation of the age-adjusted result age was centered at the mean value observed in the data; the results shown thus represent the care use experiences of a typical 78.6 year-old Finn. STATA was used for all of the calculations (Stata Corporation, 2008).

We compared growth trajectories separately for the survivors (alive 31.12.2002) and the deceased, and produced separate analyses according to educational groups as well as the married and non-married groups. We estimated all models simultaneously, with all interactions between year, gender and survival status included. Finally, we estimated days spent in care for specific causes of death. All the models were adjusted for age in single years.

Results

Table 1 shows the estimated average age-adjusted number of hospital, long-term and total care days in the seven years before death or end of follow-up (alive) obtained from growth curve models for men and women separately in three broad age-groups. Within each age band age was adjusted for in single years. Use of care increases rapidly with age particularly in the case of long-term care, and in all age-groups women use both types of care more than men. Use of care at a given age is also much higher for the deceased than the survivors. In relative terms, the total seven year excess in use of hospital and long-term care is much higher at younger ages; being between four to six fold among those aged 70–79

but under two fold among those older than 90 years. Long-term care forms a larger proportion of total care with increasing age.

[while the statement above is correct, there is a slight anomaly in the interpretation of Table 1 data in that someone in the survivor group in 2002 could die next year in 2003, whereas someone in the decedent group in 1998 could still be alive four years later – so the differences will be attenuated, it may be unnecessary to note this point]

Figure 1 shows the age-adjusted number of care days for each of the seven years before death or end of follow-up. Among the deceased, use of care rises rapidly towards the end of life. Hospital care days in the last year of life are twice the number in the second last year of life, however long-term care days rise more smoothly over a longer period of time before death and peak at a lower level. Compared to the survivors, total care use is much higher among the deceased; being about 4–5 fold in the last year of life but about 3 fold in the third year before death,

Age-adjusted educational differences in total care use are relatively small (Figure 2); about 15–30% days less in the 7 year period for the more educated among both the deceased and the survivors than for those with basic education (Table 2). Similarly the care use differences between the deceased and the survivors are only slightly larger among the basic educated; 206 days (301.8-95.4=206.4) for the basic educated and 190 days for the higher educated among men, and 300 and 264 days respectively among women (Table 2).

Differentials in total care by marital status are more substantial (Figure 3) and are largely due to long-term care, and are larger among men than women. In the year before death, married men use long-term institutional care on average 26 days less than the non-married. Similar differences in long-term care between marital status groups exist at all durations before death and cumulatively in the seven year follow-up period account to 130 days. For women, the corresponding excess days in long-term care are 24 and 100. Among both men and women survivors' marital status differences are in the same direction, but smaller. There are larger differences between the deceased and the survivors among the non-married than among the married. For married men the cumulative seven year difference in total care is 162 days and for the non-married 243 days. For women, the corresponding differences are 233 and 305. Similar differences are observed for living arrangements (results not shown here).

Care use varies strongly by cause of death (Table 3). On average, those recorded as dying of dementia use about twice the number of hospital and long-term care days as those dying from other causes. Although they account for only 12% of all deaths, these older women use about a quarter of all hospital and long-term care days among the deceased. Those dying from dementia are particularly heavy users of long-term care with a cumulated total of 674 days in the last seven years of life for women and 387 for men. Deaths related to respiratory diseases and to lesser extent cerebrovascular diseases are also associated with heavier than average care use.

Although care use for dementia is largest in the last year of life, high use is observed in all seven years before death (Figure 4, selected causes). Also cerebrovascular deaths are associated with extended care use profiles. Conversely, deaths from malignant neoplasms are associated with clearly increased hospital care days only towards the last year of life.

Discussion

Main findings and their interpretation

We have studied end of life use of hospital and long-term care in terms of average care days. While number of care days are of course associated with cost of care it should be recognized that a hospital bed day will usually be more expensive from the viewpoint of the care provider than a long-term care day. Previous Finnish analyses have directly assessed care cost before death (Häkkinen et al. 2008). However, from the viewpoint of the patient the full costs to the care provider may be unknown and irrelevant. Furthermore, bed days are a more meaningful indicator of the health status and care needs of the person concerned.

Most previous studies have assessed care use over a relatively short period before death; usually 1–2 years. However, we show that higher use of care before death is not limited to this period. The average total use of care is over 100 days more among women in the 12-month period before death than among surviving women of the follow-up at the same age and 175 days in the last two years. The average cumulative difference in the last seven years of life is about 300 days. Our results thus clearly show that the surcharge of dying is not only limited to the last few years of life.

We observed large and consistent effects of being married on lower total care use that were mostly due to long-term care (results corroborated with analyses of living arrangements). These differences also imply larger proximity of death service use among the non-married. (Note that marital status is that at baseline and, for example, some will change from married to widowed subsequently especially at older ages so that these results will tend to under-estimate the magnitude of the effect.) Those living with a partner are less likely to enter into long-term institutional care (Branch & Jette, 1982; Gaugler et al., 2007; Grundy & Jitlal, 2007; Nihtilä & Martikainen, 2008; Martikainen et al. 2009) and remain in (Martikainen et al. 2009 Freedman, 1993; Kemper & Murtaugh, 1991; Spillman & Lubitz, 2002) long-term institutional care. This effect can possibly best be understood by availability of informal care – both emotional support and task help – for the married within the household allowing married people to postpone or avoid long-term care entry. Furthermore, among those already in long-term care not having access to informal care in the household of potential return may make it more difficult to return to the community.

Education was relatively weakly associated with hospital and long-term care use with basic educated people using only 15–30 percent more days of both hospital and long-term care, a result consistent with a previous finding showing small care cost differentials by income (Häkkinen et al. 2008) It is well established that less educated people have poorer health than better educated people (Mackenbach et al, 2008) so higher use of care at a given age could have been anticipated (although total lifetime use will be offset by lower life expectancy). There are several interrelated and complex reasons why at a given level of health status better educated people may be likely to receive more care than expected. First, better educated people may be more aware of the various care alternatives. Second, they may be better able to afford care (although they might also be more likely to purchase services to enable them to remain at home which would act in the opposite direction). Third, they may be better able to negotiate care from the health care professionals possibly because of lower barriers in interaction. Fourth, in the particular case of long-term institutional care, it is also possible that better educated people once admitted to care stay and survive longer in care (Martikainen et al. 2009). Overall, these results seem to

demonstrate some accumulated disadvantage among the least educated; in spite of poorer health they do not seem to have access to corresponding levels of care. Proximity to death care use was also relatively similar for both education groups.

Lynney et al. (2003) suggest and empirically assess different functional decline patterns towards the end of life; for example sudden death being associated with no prior decline of functioning, organ failure with declining but fluctuating functioning and cancer with relatively rapid and sustained decline at the very end of life. Many of the patterns of hospital and long-term care use observed in this study can be understood within this framework and have important implications for provision of health care. By showing very different care use trajectories by cause of death our results are consistent with the idea that different types of health and long-term care resources and clinical approaches are needed for different underlying health conditions.

In particular, we were able to quantify that those dying from dementia are heavy users of long-term care with a cumulated use of 674 days in the last seven years of life for women and 387 for men. This is more than twice the average amount of long-term care compared to other causes. The high level of long-term care use is in line with the severe functional consequences of living with dementia, but use of hospital care is also raised. Further analyses not shown here show that for those dying of dementia, the married had substantially reduced age-adjusted long-term care use; married men using about half and women about 70 percent of the care used by the non-married. Also those dying of cerebrovascular and respiratory diseases were heavy care users, but average use of care was only about 50 percent of that for those dying of dementia. Cancer deaths were characterised by low use of care that only increased in the last year of life.

Methodological considerations

The distinction between long-term care and hospital care is blurred. In our data long-term care includes days spent in nursing homes, service homes with 24-hour assistance and rehabilitation care. In Finland, these care services are provided by the social services sector. Hospital care refers to days spent in either hospitals or health centers, and is provided by the health care sector. However, this distinction may be somewhat problematic if care placement is determined by availability of care places. In the Finnish context, when appropriate nursing home places are not available in certain areas, long-term care is provided in hospitals or health care centers. At older ages this would create some bias towards more hospital care at the expense of long-term nursing home care. However, adjusting for region in these data had only a negligible effect on our main results. Furthermore, it appears that individuals in long-term care establishments also experience ‘valid’ hospital care periods when needing more intensive and acute care provided in hospitals. For example, for dementia it appears that long-term care patients move from long-term care establishments to hospitals; data shown here indicate that for those dying of dementia long term care in the last year of life levels off and hospital care peaks.

The diagnosis of dementia as a cause of death is not easy and dementia remains understated as a cause in death certificates (Wachterman, Kiely and Mitchell, 2008). The degree of understatement remains unclear, as no gold-standard exists and dementia patients may suffer from many co-morbid conditions so estimates vary depending on data, definitions and methodology. Knapp and Prince (2007) estimate – on the basis of estimates on dementia prevalence and excess mortality of dementia patients – that about 10% of all deaths above age 65 are attributable to dementia among men and 15% among women in the

UK in 2005. These estimates are in line with data from New Zealand in 2006 (Tobias et al. 2008) and expectedly higher than what we observe in our data; 5.9% among men and 12.0% among women. Estimates based on proportions dying with dementia are roughly twice as high as proportions of deaths attributable to dementia (Brayne et al. 2006).

Large population-based data linking different administrative registers carry several major advantages. Longitudinal registration data with detailed information on social and health care use and various socio-demographic indicators allowed us to reliably assess use of care in the years before death. Furthermore, the data do not suffer from loss to follow-up, missing values, participant mis-reporting or lack of power, which may be serious problems with survey-based data.

Implications for future demand of care

The fastest growing section of the elderly population in developed countries is the old-old; in Finland it is anticipated that because of the ageing of the baby boom cohorts the share of the 80+ population is likely to double to about 9% by 2030 (Statistics Finland, 2009). In this context, our findings on the great importance of age as a determinant of long-term care – more so than hospital care – is of particular relevance for future care use. To contain future increases in care use and expenditure, health policy interventions should aim to maintain the activities of daily living of older people and thus prevent or at least delay long-term institutional care (Häkkinen et al 2008).

The combination of improving mortality, reduced gender differentials in mortality and the fact that the cohorts now entering retirement age were in the prime marriage ages at the time of the marriage boom of the early 1960s, imply that the proportion of older women, but not men, who are married is likely to increase for about two decades in most Western European countries (Kalogirou and Murphy, 2006). Also an increasing proportion of non-married elderly will live as a co-habiting couple (Moustgaard et al. 2009, Brown et al. 2006, Chevan 1996).

Coupled with our results showing lower care use among those living with a spouse imply that any increase in the proportion of people who are partnered will tend to reduce the demand for long-term care places. This change may partly shift the burden of care from the formal to the informal sector, particularly the family – possibly redistributing rather than reducing care. As it is likely that the proportion of partnered women but not men will grow, more demand for informal care giving may be expected from male partners, a source of informal care not traditionally relied on, although partnered older people are also more likely to have and to retain contact with their children.

The rising trend of dementia is well established globally. Deaths due to dementia have grown rapidly in the past two decades, and are likely to grow further (Brayne et al. 2006, Di Cesare and Murphy 2010). The increase in dementia is probably due at least partly to changes in diagnostic practices, but purely because of increasing life-expectancy and age at death the number of dementia deaths are likely to keep rising rapidly and their share of all deaths to rise; possibly doubling in the next 25 years (Di Cesare and Murphy 2010, Tobias et al. 2008, Knapp and Prince 2007, Prince and Jackson 2009) By showing high use of hospital and long-term care among dementia patients (particularly those non-married) our results demonstrate that this is likely to mean a major shift towards higher care needs in the future.

Conclusions

The greater importance of age as a determinant of long-term care use as compared with the relevance of proximity to death for hospital care is confirmed, but both are relevant to needs. The volume of long-term care required (as measured by bed days) is greater than hospital care for the old-old. Differentials in service use by marital status are substantial and, in particular, care use is considerably higher among the non-married in the period close to death. While changes in marital status distributions are reasonably easy to predict for the older population in years to come, the assumption that this may lead to substantial benefits due to the increased proportions of older married women due to smaller proportions of widows are likely to be offset by increases in the high-service users of never-married and divorced people (Kalogirou and Murphy 2006). It would therefore be sensible to include the changing socio-demographic composition of the population, especially marital status and proximity to death, in future projections of both hospital and long-term care need.

References

Branch, L. G., & Jette, A. M. (1982). A prospective study of long-term care institutionalization among the aged. American Journal of Public Health, 72, 1373—1379.

Brayne C, Gao L, Dewey M, Matthews FE, (2006), Dementia before Death in Ageing Societies— The Promise of Prevention and the Reality. PLoS Med 3(10): e397.

Brockmann, H. (2002), Why is less money spent on health care for the elderly than for the rest of the population? Health care rationing in German hospitals. *Social Science & Medicine*, 55, pp. 593–608.

Brown, S. L., Lee, G. R., & Bulanda, J. R. (2006). Cohabitation Among Older Adults: A National Portrait. Journal of Gerontology: Social Sciences, 61B(2), 71–79.

Chen JH, Chan DC, Kiely DK, Morris JN, Mitchell SL. (2007), Terminal trajectories of functional decline in the long-term care setting. J Gerontol A Biol Sci Med Sci. May;62(5):531-6.

Chevan, A. (1996). As Cheaply as One: Cohabitation in the Older Population. Journal of Marriage and the Family, 58 (3), 656–667.

Forma L, Rissanen P, Aaltone M, Raitanen J, Jylhä M. (2009), Age and closeness of death as determinants of health and social care utilization: a case-control study. Eur J Public Health. 2009 Jun;19(3):313-8.

Di Cesare M, Murphy M. (2009), Deaths from dementia and related causes among older people in England and Wales 1911-2057: past trends and future forecasts. Manuscript2009.

Freedman, V. A. (1993). Kin and nursing home lengths of stay: a backward recurrence time approach. Journal of Health and Social Behavior, 34, 138—152.

Gaugler, J., Duval, S., Anderson, K., & Kane, R. (2007). Predicting nursing home admission in the U.S: a meta-analysis. BMC Geriatrics, 7, 13.

Grundy, E., & Jitlal, M. (2007). Socio-demographic variations in moves to institutional care 1991-2001: a record linkage study from England and Wales. Age and Ageing, 36, 424—430.

Hoover, D.R., Crystal, S., Kumar, R., Sambamoorthi, U., and Cantor, J.C., (2002), Medical expenditures during the last year of life: findings from 1992–1996, Medicare current beneficiary survey, Health Service Research, 37 (6), pp. 1625–1642.

Häkkinen U, Martikainen P, Noro A, Nihtilä E, Peltola M. (2008), Aging, health expenditure, proximity to death, and income in Finland. Health Econ Policy Law. 2008Apr;3(Pt 2):165-95.

Kalogirou, S., & Murphy, M. (2006). Marital status of people aged 75 and over in nine EU countries in the period 2000–2030. European Journal of Ageing, 3, 74-81.

Kemper, P., & Murtaugh, C. M. (1991). Lifetime use of nursing home care. The New England Journal of Medicine, 324, 595—600.

Knapp M, Price M. Dementia UK. (2007), The full report. London: Alzheimer's Society, 2007

Lunney JR, Lynn J, Foley DJ, Lipson S, Guralnik JM. (2003), Patterns of functional decline at the end of life. JAMA. May 14;289(18):2387-92.

Mackenbach JP, Stirbu I, Roskam AJ, Schaap MM, Menvielle G, Leinsalu M, Kunst AE; (2008), European Union Working Group on Socioeconomic Inequalities in Health. Socioeconomic inequalities in health in 22 European countries. N Engl J Med. 2008 Jun 5;358(23):2468-81.

Martikainen P, Moustgaard H, Murphy M, Nihtilä E, Koskinen S, Martelin T, Noro A. (2009), Gender, living arrangements and social circumstances as determinants of entry into and exit from long-term institutional care at older ages – a six year follow-up study of older Finns. *The Gerontologist*, 49, pp. 34-45.

McGrail K, Green B, Barer ML, et al (2000), Age, costs of acute and long-term care and proximity to death: evidence for 1987/88 and 1994/95 in British Columbia, Age and Ageing 29: 249-253

Moustgaard H, Martikainen P. (2009), Non-marital Cohabitation among Older Finnish Men and Women: Socioeconomic Characteristics and Forms of Union Dissolution. J Gerontol B Psychol Sci Soc Sci. 2009 Jun;64(4):507-16.

Murphy M, and Martikainen P. (2010, forthcoming) Demand for long-term residential care and acute health care by older people in the context of ageing populations: a general overview of drivers for care and a case-study of Finland with particular emphasis on age and proximity to death. In R Scholz and G Doblhammer (eds) *Aging, Care Need, and Quality of Life*. VS Verlag and Deutscher Universitätsverlag, 20010, forthcoming.

Nihtilä, E., & Martikainen, P. (2007). Household income and other socio-economic determinants of long-term institutionalisation among older adults. Population Studies Nov;61(3):299-314.

Nihtilä, E., & Martikainen, P. (2008). Why older people living with a spouse are less likely to be institutionalised: the role of socio-economic factors and health characteristics. Scandinavian Journal of Public Health, 36, pp. 35-43.

Prince, M., & Jackson, J. (2009) *World Alzheimer Report 2009*, available at www.alz.co.uk/research/files/World%20Alzheimer%20Report

Rabe-Hesketh, S. & Skrondal, A. (2008). Multilevel and Longitudinal Modeling Using Stata (2nd Edition). Stata Press. College Station Texas, Stata Corporation.

Seshamania, M. and Gray, A., (2004a), A longitudinal study of the effects of age and time to death on hospital costs, *Journal of Health Economics*, 23, pp. 217 – 235.

Seshamania, M. and Gray, A., (2004b), Ageing and health-care expenditure: the red herring argument revisited, Health Economics, 13, pp. 303 – 314.

Spillman BC, Lubitz J. (2000) The effect of longevity on spending for acute and long-term care. New England Journal of Medicine 11;342(19):1409-15.

Spillman, B. C., & Lubitz, J. (2002). New estimates of lifetime nursing home use: have patterns of use changed? Medical Care, 40, 965—975.

Stata Corporation. (2008). Stata Statistical Software. Release 10.1. College Station TX. Stata Corporation.

Stearns, S.C. and E.C. Norton (2004), 'Time to include time to death? The future of health care expenditure?' Health Economics, 13(4): 315–327.

Tobias, Martin, Yeh, Li-Chia & Johnson, Elizabeth (2008). Burden of Alzheimer's disease: population-based estimates and projections for New Zealand, 2006–2031. Australian and New Zealand Journal of Psychiatry, 42 (9), 828-836.

Wachterman M, Kiely DK, Mitchell SL. (2008), Reporting dementia on the death certificates of nursing home residents dying with end-stage dementia. JAMA. 2008 Dec 10;300(22):2608-10.

Wanless, Derek. (November 2001) Securing our Future Health: Taking a Long-Term View: an Interim Report and April 2002 Securing Our Future Health: Taking a Long-Term View: Final Report. (available at http://www.hm-treasury.gov.uk/Consultations_and_Legislation/wanless/consult_wanless_index.cfm).

Yang Z, Norton EC, Stearns SC. (2003) Longevity and health care expenditures: the real reasons older people spend more. Journals of Gerontology Series B Psychological Sciences Social Sciences 58(1):S2-10.

Table 1. Age-adjusted average number of hospital, long-term and total care days in the previous seven years among the deceased and survivors by age and sex

Sex	Age*	Survival status	N	Average number of days: Hospital care	Long-term care	Total care	Ratio: LTC/Total
Men	70-79	Survivors	61751	30.7	20.0	50.7	0.39
		Deceased	14231	144.6	73.7	218.2	0.34
		Deceased / Survivors		4.7	3.7	4.3	
		Deceased - Survivors		113.9	53.7	167.6	
	80-89	Survivors	18873	64.5	78.1	142.6	0.55
		Deceased	11501	194.9	168.3	363.2	0.46
		Deceased / Survivors		3.0	2.2	2.5	
		Deceased - Survivors		130.5	90.2	220.7	
	90+	Survivors	2091	109.6	228.0	337.6	0.68
		Deceased	3084	236.2	331.6	567.8	0.58
		Deceased / Survivors		2.2	1.5	1.7	
		Deceased -Survivors		126.7	103.6	230.2	
Women	70-79	Survivors	90782	31.4	26.0	57.4	0.45
		Deceased	11368	198.0	120.8	318.8	0.38
		Deceased / Survivors		6.3	4.6	5.6	
		Deceased - Survivors		166.6	94.8	261.4	
	80-89	Survivors	46490	81.6	125.1	206.7	0.61
		Deceased	20157	262.6	277.6	540.3	0.51
		Deceased / Survivors		3.2	2.2	2.6	
		Deceased - Survivors		181.1	152.5	333.6	
	90+	Survivors	7825	174.4	385.5	559.9	0.69
		Deceased	9803	352.8	535.5	888.3	0.60
		Deceased / Survivors		2.0	1.4	1.6	
		Deceased -Survivors		178.4	150.0	328.4	

* Age at year of death / end of follow-up, centered at agegroup mean

Table 2. Age-adjusted average cumulative seven year hospital, long-term and total care days among the deceased and survivors by sex, education and marital status

Sex	Survival status	Cumulative number of days: Hospital care	Long-term care	Total care
Men	All			
	Survivors	43.9	46.7	90.6
	Deceased	167.7	123.3	291.0
	Marital status			
	Married			
	Survivors	37.6	27.7	65.3
	Deceased	153.1	73.8	227.0
	Non-married			
	Survivors	60.7	91.6	152.3
	Deceased	191.5	203.6	395.1
	Education			
	Higher			
	Survivors	37.8	34.2	72.0
	Deceased	168.6	93.6	262.2
	Basic			
	Survivors	46.2	49.3	95.4
	Deceased	168.1	133.7	301.8
Women	All			
	Survivors	56.6	82.1	138.7
	Deceased	229.3	205.7	434.9
	Marital status			
	Married			
	Survivors	43.6	51.0	94.6
	Deceased	201.7	125.9	327.6
	Non-married			
	Survivors	64.0	96.9	160.9
	Deceased	240.3	225.6	465.9
	Education			
	Higher			
	Survivors	48.7	69.3	118.0
	Deceased	217.3	164.4	381.7
	Basic			
	Survivors	58.4	82.4	140.7
	Deceased	233.0	207.4	440.4

Table 3. Cumulative seven year distribution of deaths with age-adjusted cumulative seven year average care days and number (in 1000s) of hospital days and long-term care days by cause of death and sex

Men

Cause of death	Deaths		Total hospital days			Total LTC days		
	No	%	Average	in 1000s	%	Average	in 1000s	%
Ischaemic heart disease	9409	30.3	114.2	1074.5	20.6	87.0	818.6	21.1
Cerebrovascular diseases	2998	9.7	244.7	733.6	14.0	157.9	473.4	12.2
Other diseases of the circulatory system	1103	3.6	121.5	134.0	2.6	98.3	108.4	2.8
Dementia	1818	5.9	433.5	788.1	15.1	387.0	703.6	18.1
Malignant neoplasms	7043	22.7	117.6	828.3	15.9	60.4	425.4	11.0
Diseases of the respiratory system	3661	11.8	214.0	783.5	15.0	190.0	695.6	17.9
Other diseases	3227	10.4	201.9	651.5	12.5	153.7	496.0	12.8
Accidents & violence	1293	4.2	112.2	145.1	2.8	81.6	105.5	2.7
Other or unknown	498	1.6	168.8	84.1	1.6	114.6	57.1	1.5
All deaths	31050	100.0	168.2	5222.6	100.0	125.1	3883.5	100.0
Deaths	31050	27.3	168.2	5222.6	57.5	125.1	3883.5	55.9
Survivors	82715	72.7	46.6	3854.5	42.5	56.1	3064.9	44.1
Total	113765	100.0	79.8	9077.1	100.0	61.1	6948.4	100.0

Women

Cause of death	Deaths		Total hospital days			Total LTC days		
	No	%	Average	in 1000s	%	Average	in 1000s	%
Ischaemic heart disease	12108	28.6	215.4	2608.1	20.6	244.4	2959.2	22.0
Cerebrovascular diseases	5635	13.3	344.3	1940.1	15.3	310.2	1748.0	13.0
Other diseases of the circulatory system	1843	4.3	239.6	441.6	3.5	284.6	524.5	3.9
Dementia	5094	12.0	602.3	3068.1	24.2	673.7	3431.8	25.6
Malignant neoplasms	6785	16.0	181.6	1232.2	9.7	136.6	926.8	6.9
Diseases of the respiratory system	3394	8.0	361.4	1226.6	9.7	467.6	1587.0	11.8
Other diseases	5879	13.9	307.1	1805.4	14.2	324.1	1905.4	14.2
Accidents & violence	1274	3.0	196.8	250.7	2.0	212.8	271.1	2.0
Other or unknown	389	0.9	269.7	104.9	0.8	190.9	74.3	0.6
All deaths	42401	100.0	299.0	12677.7	100.0	316.7	13428.1	100.0
Deaths	42401	22.6	299.0	12677.7	60.9	316.7	13428.1	55.0
Survivors	145097	77.4	56.1	8139.9	39.1	79.4	10977.2	45.0
Total	187498	100.0	111.0	20817.7	100.0	130.2	24405.3	100.0

Figure 1. Age-adjusted average number of hospital, long-term and total care days in the previous seven years among the deceased and the survivors by sex

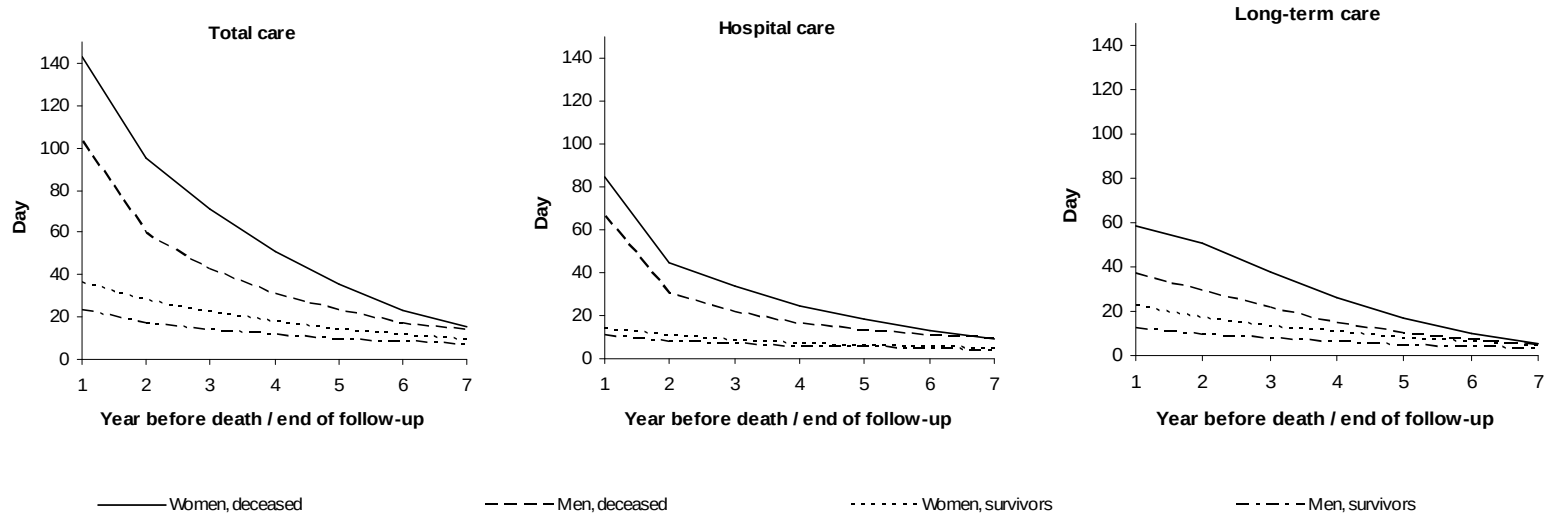


Figure 2. Education differences in age-adjusted average number of hospital, long-term and total care days in the previous seven years among the deceased and the survivors by sex

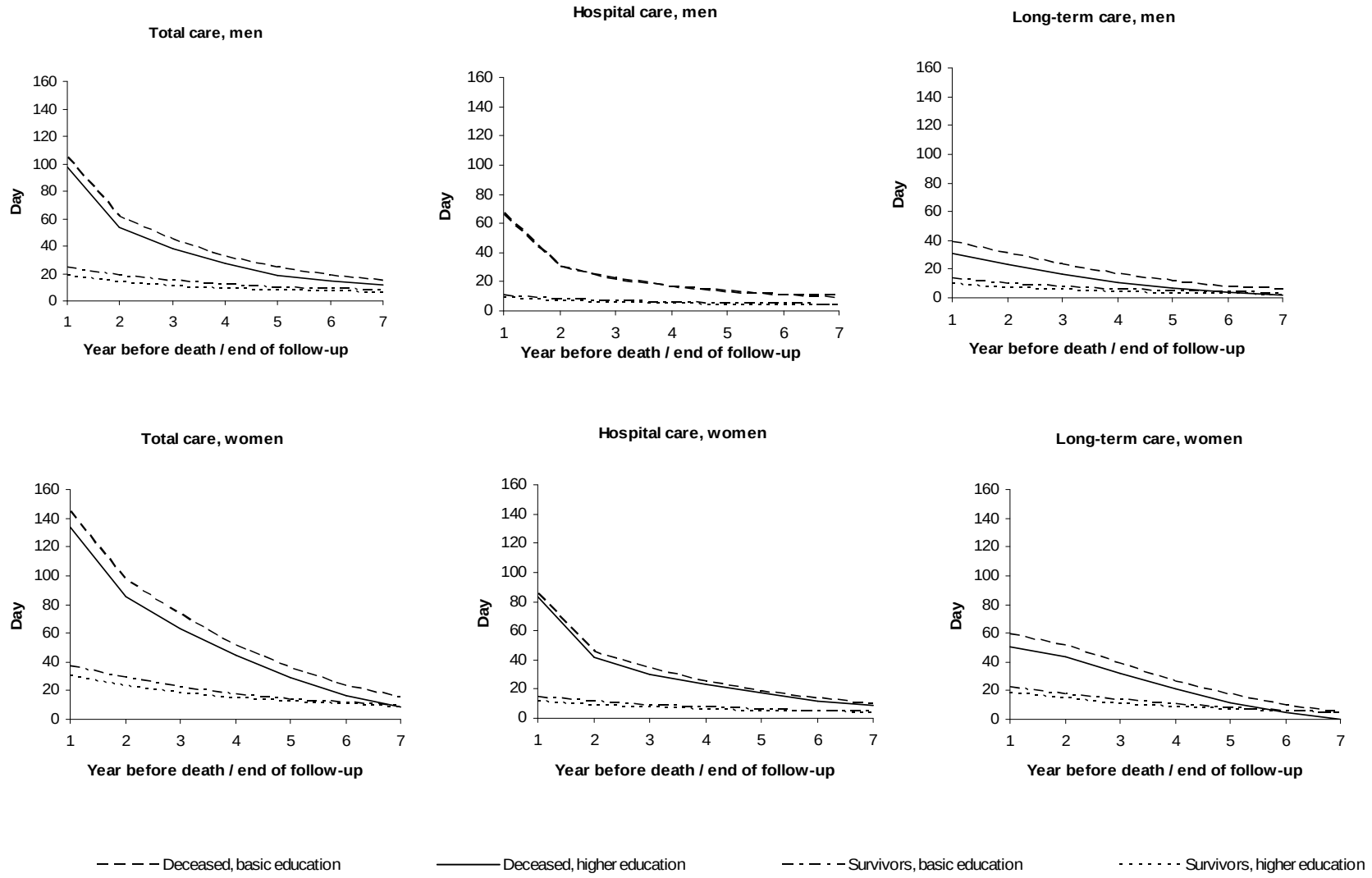


Figure 3. Marital status differences in age-adjusted average number of hospital, long-term and total care days in the previous seven years among the deceased and the survivors by sex

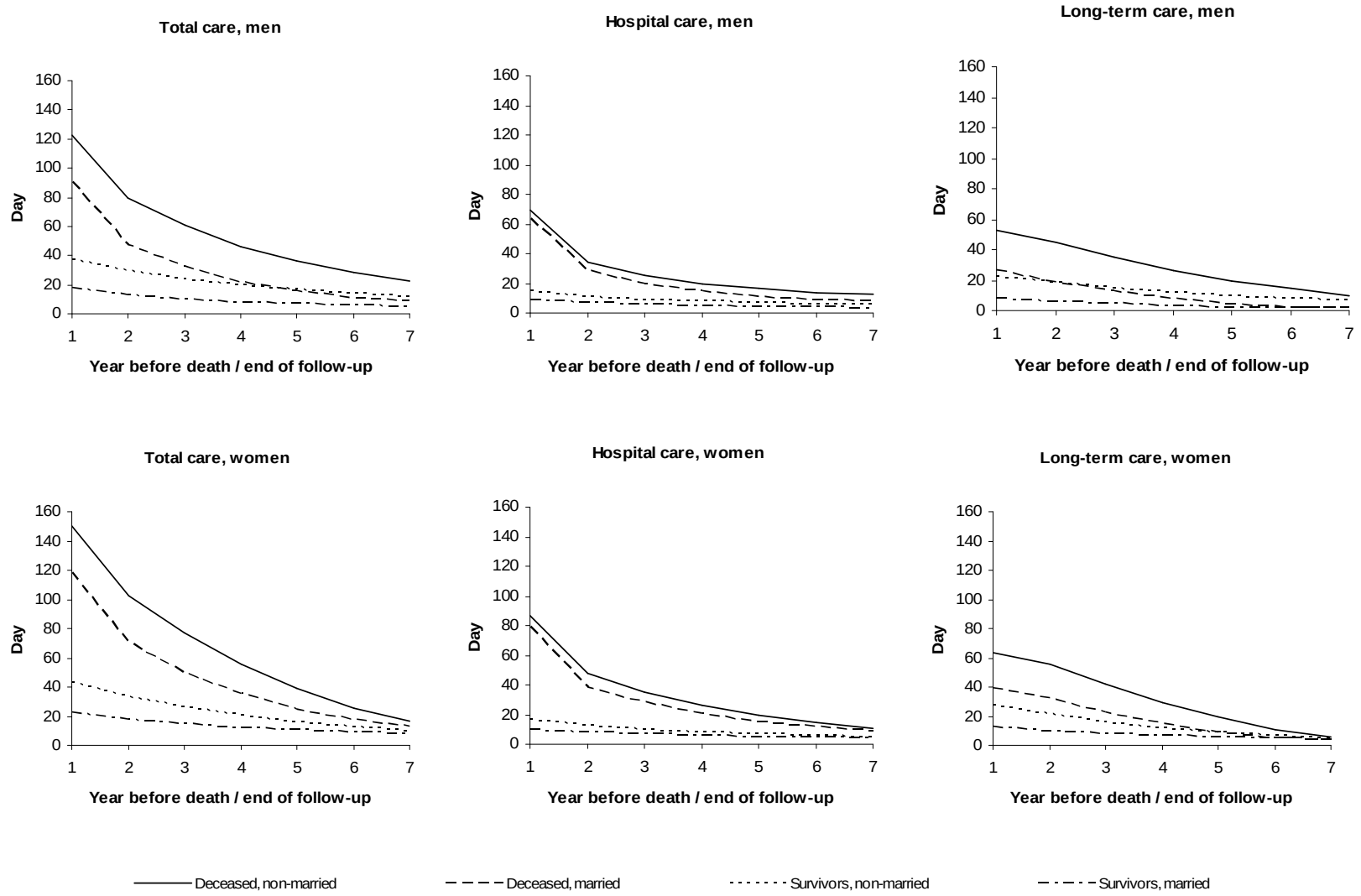
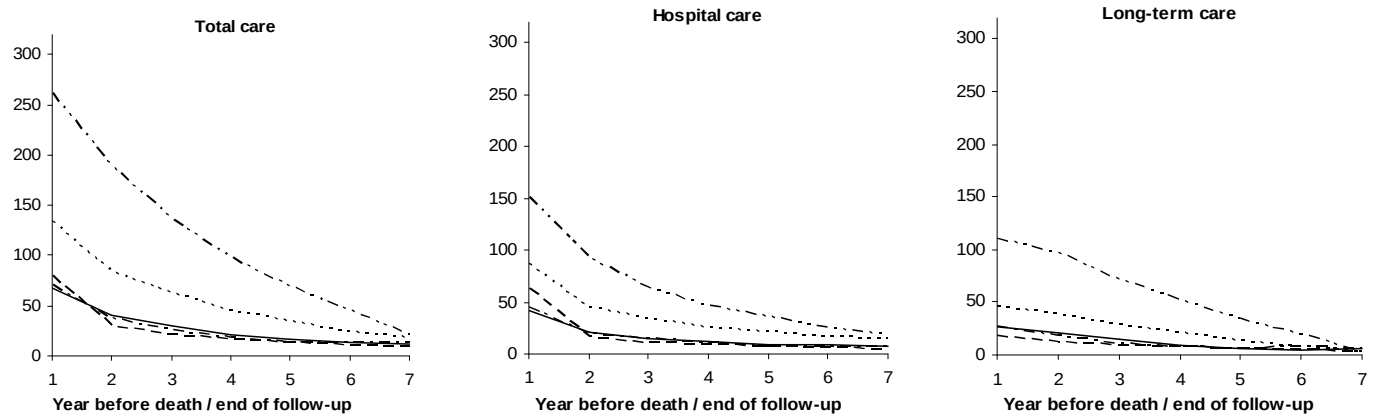


Figure 4. Age-adjusted average number of hospital, long-term and total care days in the previous seven years before death by cause of death and sex

Men



Women