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Abstract

Geographical and temporal Understanding In place of Death in England (1984–2010): analysis of trends and associated factors to improve end-of-life Care (GUIDE_Care) – primary research

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Background: Place of death (PoD) has been used as an outcome measure for end-of-life care. Analysis of variations in PoD can improve understanding about service users' needs and thus better target health-care services.

Objectives: (1) To describe PoD in England by demographic, socioeconomic and temporal variables; (2) to determine how much of the variation in PoD can be explained by potential explanatory variables at the area level, and building on this to develop individual-level multivariable regression models; and (3) to evaluate factors associated with PoD and to construct risk assessment models to inform practice.

Methods: A population-based study of all registered deaths between 1984 and 2010 in England ($n = 13{,}154{,}705$). The outcome was the PoD. Explanatory variables included age, gender, cause of death (CoD), marital status, year of death, whether or not the death was in a holiday period (Christmas, Easter, New Year), season of death, the location of usual residence and area-level deprivation. The proportion of explained variation in PoD was estimated using the weighted aggregate-level linear regression. Factors associated with PoD were investigated using generalised linear models. The risk assessment models were constructed using the 2006–9 data; the performance was evaluated using the 2010 data.

Results: Hospital was the most common PoD in 2001–10 [overall 57.3%; range – cancer 46.1% to chronic obstructive pulmonary disease (COPD) 68.3%], followed by home [overall 19.0%; range – cerebrovascular disease (CBD) 6.7% to cardiovascular disease 27.4%] or care home (overall 17.2%; range – cancer 10.1% to neurological conditions 35.2%), depending on CoD. Over the period, the proportion of hospital deaths for people who died from non-cancer increased (57.1–61.2%) and care home deaths reduced (21.2% down to 20.0%); a reverse pattern was seen for those who died of cancer (hospital: reduced, 48.6–47.3%; care home: increased, 9.3–10.1%). Hospice deaths varied considerably by CoD (range – CBD 0.2% to cancer 17.1%), and increased slightly overall from 4.1% in 1993–2000 to 5.1% in 2001–10. Multivariable analysis found that hospital deaths for all causes combined were more likely for people aged 75+ years [proportion ratios (PRs) 0.863–0.962 vs. aged 25–54 years], those who lived in London (PRs 0.872–0.988 vs. North West), those who were divorced, single and widowed (PRs 0.992–1.001 vs. married), those who lived in more deprived areas (PRs 0.929–1.000 more deprived vs. less deprived) and those who died in autumn, winter or at New Year. We were able to develop risk assessment models but the areas under the receiver operating characteristic curve indicating poor predictive performance, ranging from 0.552 (COPD) to 0.637 (CBD).

Conclusions: Hospital remains the most common PoD, followed by home and care home. Hospices play an important role for people who died from cancer but little for other diseases. Place of death is strongly associated with the underlying CoD. The variation in PoD by region, age, marital status and area deprivation suggests that inequities exist, which services and clinical commissioning groups could seek to address.

Funding: The National Institute for Health Services and Delivery Research programme.

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AUC	area under the receiver operating characteristic curve
CBD	cerebrovascular disease
CI	confidence interval
CoD	cause of death
COPD	chronic obstructive pulmonary disease
CVD	cardiovascular disease
df	degrees of freedom
EWD	excess winter death
GIS	geographic information system
ICD-9	*International Classification of Diseases*, Ninth Edition
ICD-10	*International Classification of Diseases*, Tenth Edition
ICD	*International Classification of Diseases*
ICU	intensive care unit
IMD	Index of Multiple Deprivation
KCL	King's College London
LA	local authority
LSOA	lower layer super output area
ONS	Office for National Statistics
OR	odds ratio
PAG	Project Advisory Group
PCO	primary care organisation
PoD	place of death
PR	proportion ratio
SD	standard deviation
SES	socioeconomic status

Plain English summary

Information on where people die is essential for public health planning and end-of-life care policy. In this study we aimed to describe where people died over a 27-year period. We also wanted to find out what factors might be related to this.

We extracted information from death registrations collected by the Office for National Statistics. We assessed all deaths registered in England between 1984 and 2010. We used statistical and mathematical research to analyse where people died and the related factors.

We analysed the death registration records of over 13 million people. Just under two-thirds had died in hospitals. The second and the third most common place of death (PoD) varied according to the cause of death. Hospices played an increasing role over time but almost exclusively for people with cancer. Hospital deaths were more likely for people aged > 75 years; divorced, single or widowed; from more deprived areas; during winter, autumn and at New Year; and in metropolitan regions. The variations in PoD need to be addressed by clinical services and commissioning groups.

Scientific summary

Background

Place of death (PoD) has been used as an outcome measure for end-of-life care. It is related to the quality of life of patients at the end of life, bereavement outcomes of caregivers, and costs of end-of-life care. Analysis of variations in PoD can improve understanding about the needs of service users, and help guide evidence-based service design and delivery. However, no in-depth individual-level analysis over time has been performed since 1994, and no study has investigated the temporal variations (e.g. seasons, specific holiday periods) in PoD.

Objectives

To:

- describe PoD in England by demographic, socioeconomic and temporal variables
- determine how much of the variation in PoD can be explained by potential explanatory variables at the area level, and building on this to develop individual-level multivariable regression models
- evaluate factors associated with PoD and to construct risk assessment models, for all causes combined and for selected causes of death.

Methods

The study was population based. All registered deaths that occurred between 1984 and 2010 in England, excluding those who died from external causes or those who died at the age of ≤ 24 years, were included in this report ($n = 13,154,705$). The outcome variable was the PoD, classified into four categories (hospital, home, other communal establishment, elsewhere) for the 1984–92 data, and six categories (hospital, own home, hospice, care home, other communal establishment, elsewhere) for the 1993–2010 data.

Explanatory variables include both individual- and area-level variables. Individual-level variables included age, gender, underlying cause of death (CoD), marital status, year of death, the region of usual residence; area-level variables were obtained through record linkage of the usual residence to measure at the lower layer super output area level or other appropriate geographic boundaries. Records with missing, illogical and invalid values on the key set of variables were deleted. Age was predominantly analysed as a categorical variable in five groups: 25–54, 55–64, 65–74, 75–84 and 85+ years. These age cut-off values are in line with commonly used age groupings to facilitate cross-study comparisons, and usefulness for policy development and targeting improvement. Gender was a binary variable (female vs. male). Marital status was included as an individual-level variable and grouped into five classes: married, widowed, divorced, single and not stated or unknown. The marital status was not available in the data before 1988, and until 1994 this variable was not universally consistent with those of post 1993; therefore, analysis using this variable was carried out for post-1993 data only. Year of death was directly extracted from the death certificate and was the year that death occurred. The location of usual residence was used to identify in which one of the 10 health authority regions the deceased lived: North East, North West, Yorkshire and the Humber, East Midlands, West Midlands, East of England, London, South East Coast, South Central and South West. The underlying CoD was identified using the *International Classification of Diseases* (ICD) coding system [ICD, Ninth Edition (ICD-9) for 1984–92; ICD, Tenth Edition (ICD-10) for 1993–2010] and grouped into seven classes: all CoDs, all non-cancer CoDs, cancer, cardiovascular diseases

(CVDs), cerebrovascular diseases (CBDs), neurological conditions and chronic obstructive pulmonary diseases (COPDs). The Index of Multiple Deprivation (IMD) was used as a proxy indicator for socioeconomic status. IMD 2000 was used for the 1984–2000 data and IMD 2010 for the 2001–10 data. Temporal variables for this report were defined as seasonal period (spring, summer, autumn, winter) and holiday period (Christmas, New Year and Easter). The seasonal period was defined by month of death according to the following cut-offs: spring (March to May), summer (June to August), autumn (September to November) and winter (December to February). The Christmas, New Year and Easter holiday period were defined as 3 days before and after the specified holiday. Before the analysis, data were checked for completeness, problems and errors.

Variations in PoD at the aggregate level were analysed and modelled using the weighted linear regression models. The dependent variable was the area-specific percentage of hospital deaths, with the total number of deaths at the selected area level as one of the adjusted variables. The proportion that can be explained by the model was derived from the model and measured using R^2. The explanatory variables were derived from the data and introduced into the models as the percentage of a defined subcategory for categorical data (e.g. gender) or average value for continuous data (e.g. age). The models were constructed using the 1993–2010 data, as the demographic variables in the pre-1993 data were limited and subject to a number of changes, and the geographic boundaries in the earlier period (1984–92) underwent significant changes. The explanatory variables included average age, percentage male, percentage married, year of death, average IMD score, percentage winter deaths or percentage deaths in the Christmas period. The area was defined at the primary care organisation (PCO) and local authority (LA) level, and modelled separately.

Factors associated with PoD at the individual level were investigated using either log-binomial regression models, or modified Poisson regression models in the case of convergence problems with the former. The dependent variable was a binary indicator of PoD. We considered the least preferred PoD [hospital (1)] compared with the second or the third most common PoD (0), which was determined by the CoD of interest. All selected independent variables, as informed by the area-level modelling analysis, were forced to stay in the model to adjust for their potential confounding effects.

We also constructed individual-level risk models for selected CoDs, to assess an individual's risk of dying in a hospital or a non-hospital setting. A non-hospital was a place other than a UK NHS- or non-NHS hospital. Given the changing patterns that we found in a recently published study on cancer deaths in England, we used the 2006–9 data as the training set to build the model, and the predictive performance was tested using the 2010 data (validation set). The model performance validation was evaluated using (1) a Wald chi-squared test and (2) the area under the receiver operating characteristic curve (AUC) and its 95% confidence interval (CI). An AUC of 0.5 indicates chance prediction (equivalent to flipping a coin), whereas a statistic of 0.7 indicates good discriminating ability. All analysis was undertaken separately for all causes, non-cancer, cancer, CVD, CBD, neurological conditions and COPD.

Results

Over the whole period 1984–2010, people died at an increasingly older age; the average age of death in 1984–92 was 75.3 years, in 1993–2000 it was 76.8 years and in 2001–10 it was 77.9 years. The proportion of those who died aged > 75 years increased from 58.2% in 1984–92 to 67.9% in 2001–10. Hospital was the most common PoD, regardless of CoD. Neurological conditions had the lowest proportion of hospital deaths (46.1% in 2001–10) and COPD most commonly occurred in hospital (68.3% in 2001–10). The second most common PoD for cancer deaths was at home (24.1%), whereas in non-cancer deaths the second most common PoD was a care home (20.0%). Neurological conditions had the highest proportion of care home deaths (35.2%); for other conditions, care home deaths accounted for around 10% of deaths. In total, 17.1% of all cancer deaths and 3.5% of the deaths from neurological conditions occurred in a hospice. For other causes of deaths the proportion of hospice deaths was < 1%.

Regional-level models using selected demographic and clinical variables together with a temporal variable explained a statistically significant ($p < 0.001$) proportion of variations in hospital deaths, ranging from 24.3% to 26.7% for all causes combined. The models constructed at the PCO level tended to perform slightly better than those at the LA level; models incorporating holiday periods marginally outperformed those incorporating the seasonal temporal variable. The disease-specific models varied widely between diseases. The selected variables explained the lowest proportion of PoD variations in cancer (5.4–6.9%), and the highest in CBDs (38.2–39.0%) for PCO-level models, and in non-cancer (36.5–37.2%) for LA-level models.

For all causes, the probability of a person dying at home decreased with increasing age across all time periods; however, the age gap reduced over time [proportion ratios (PRs) range 0.863–1.016], compared with patients who died aged 25–54 years. Home death was less likely among those who were aged 75+ years in all causes of deaths in the period 1993–2010 (PRs 0.938–0.962). Patients aged 85+ years had the lowest chance of dying at home (PRs 0.863–0.946). Male gender was associated with an increased chance of dying at home but this was more pronounced in earlier periods (PR 1.034, 95% CI 1.032 to 1.036) than in recent periods (PR 1.007, 95% CI 1.007 to 1.008 for 1993–2000; PR 1.009, 95% CI 1.008 to 1.009 for 2001–10). Divorced people were less likely to die in hospitals (PR 0.998, 95% CI 0.997 to 0.999) in 1993–2000 but more likely to die in hospital in 2001–10 (PR 1.027, 95% CI 1.024 to 1.030). Compared with people who were married, those who were widowed or single were more likely to die in hospital (PRs 0.992–0.998). Over the years, deaths in hospital became more likely (PR 1.001, 95% CI 1.000 to 1.002, in 2001–10 vs. PR 0.998, 95% CI 0.998 to 0.999, in 1993–2000). Living in a more deprived area was associated with a higher chance of hospital death; however, this was more pronounced in 1984–92 than in 1993–2010 (PRs 1.000–1.010 vs. PRs 1.030–1.076 for least deprived compared with most deprived). In all three periods, living in London was associated with the highest chance of dying in hospital (PRs 0.872–0.988 vs. North West) and those in the South West had the highest chance of home death (PRs 1.010–1.062 vs. North West).

Care home death was more likely among older people for all causes of death in 1993–2010 (PRs 0.941–0.996). Compared with care home death, men were more likely to die in hospital than women (PRs 1.008–1.010) in the whole period; those who were married had a higher chance of dying in hospital than those who were widowed, single, divorced or had unknown marital status (PRs 0.984–0.992) in recent periods; in the periods of 1993–2000 and 2001–10, widowed people had the highest chance of a care home death (PR 0.980, 95% CI 0.979 to 0.981, in 1993–2000; PR 0.985, 95% CI 0.985 to 0.986, in 2001–10). The number of care home deaths fell slightly in the period 1984 to 2000 (PRs 1.001–1.022) but remained stable for the period of 2001–10 (PR 1.000, 95% CI 0.999 to 1.000). Care home death was less likely among the least deprived (PRs 0.992 to 0.997 compared with the most deprived). Care home death was less likely in London than in the North West (PRs 1.012–1.016) but the regional gap reduced in 2001–10; South West areas had the highest chance of care home death (PRs 0.993–0.994).

Compared with the normal (i.e. non-holiday) period, there were slightly increased chances of dying in hospital rather than at home during the Christmas period for people from non-cancer conditions in 1993–2000 (PR 1.002, 95% CI 1.001 to 1.004); cancer in 1984–92 (PR 1.019, 95% CI 1.009 to 1.029) and 2001–10 (PR 1.003, 95% CI 1.000 to 1.006); CVD in 1993–2000 (PR 1.004, 95% CI 1.001 to 1.006) and neurological conditions in 1984–92 (PR 1.052, 95% CI 1.012 to 1.093). The probability of home death increased during the Christmas period for people who died from COPD in 1984–92 (PR 0.975, 95% CI 0.953 to 0.998). For CBD CoD, no statistically significant difference was found between Christmas and the normal period in any time periods ($p > 0.05$). A reduced chance of hospital death during the Easter period was observed for all causes of death in 2001–10 (PR 0.998, 0.997 to 0.999) and non-cancer deaths in 1984–92 (PR 0.994, 95% CI 0.987 to 1.000) and in 2001–10 (PR 0.998, 95% CI 0.997 to 1.000). The New Year period was associated with increased hospital deaths for the whole study period for deaths from all causes (PRs 1.002 to 1.016), non-cancer (PRs 1.007– 1.029) and CVD (PRs 1.010–1.035). With spring as the reference group, the chance of a hospital death was lower for all causes of deaths in the summer season in 1984–92 (PR 0.992, 95% CI 0.990 to 0.995) but the chance of a hospital death increased to a similar level as spring in 1993–2000 (PR 1.000, 95% CI 0.999 to 1.000). Up to the period 2001–10, the probability of hospital death in summer was higher than in spring for all causes of death (PR 1.002, 95% CI 1.001 to 1.002).

The AUC ranged from 0.552 (95% CI 0.551 to 0.554) for COPD CoD to 0.637 (95% CI 0.632 to 0.643) for CBD deaths. Although the performances of the model in the validation set were all significant at the level of $p < 0.0001$, none was deemed satisfactory.

Conclusions

This large-scale population-based study using 27 years of death registration data for England found that the most common PoD remains hospital, followed by home or care home, depending on the CoD. Hospices played an increasing role over time but primarily for people with cancer (17.1% of cancer deaths were in a hospice) but only 3.5% of neurological conditions, and < 1% of other conditions. There is regional variation in PoD: people from populated metropolitan areas (particularly London) were more likely to die in hospitals than elsewhere, which highlights a need to either plan for increased hospital deaths in these areas or examine ways to support more people to die in the community. PoD also varied slightly by season and holiday periods, with autumn and winter deaths (compared with spring deaths) having an increased chance of occurring in hospital, and a higher chance of home deaths during the Christmas period and hospital deaths during the New Year period than in the normal period. For all causes of death, there is evidence of inequality in PoD by age, marital status and deprivation. People who are aged 75+ years, single, divorced or widowed, and those living in more deprived areas were more likely to die in hospital. The predictive performance of our risk assessment models was not satisfactory and needs further development to take into account service provision and other important factors.

Recommendations for future research

This report has identified the following priority research questions:

- What is the pattern of health service utilisation in the last year of life and how is it related to where patients die?
- How are clinical characteristics in the last year of life related to where patients die?
- Is the distribution of end-of-life care facilities related to where patients die?

Funding

The National Institute for Health Services and Delivery Research programme.

Chapter 1 Background

Place of death (PoD) is regarded and used as an outcome measure for end-of-life care.[1–3] It is important for public health planning and policy-making, and resource allocation, as well as effective service design and delivery.[4] It is closely related to the quality of life of the patient and their family members. A prospective and multicentre cohort study of 342 patients with advanced cancer and their carers found that those patients who died in a hospital or intensive care unit (ICU) had significantly worse quality of life, and they experienced more physical and emotional distress than patients who died at home with hospice service.[5] The study also found that, compared with home hospice death, ICU death was associated with a heightened risk for post-traumatic stress disorder and an increased risk for developing psychiatric illness in bereaved carers.[5] Similar associations are also evident in non-cancer terminal conditions, although the data are not as enriched as for cancer deaths.[6–8]

Where a patient dies also has cost implications, as PoD is closely related to place of care and health-care utilisation. A large-scale empirical analysis on data from 58,732 Swiss residents revealed substantial and significant differences in health-care utilisation in the last 6 months of life according to PoD.[9] Those who died at home had only half of the expenditure on end-of-life care as those who died at hospital. Studies from other countries with similar or distinctive health-care systems are universally in agreement with the findings from the Swiss study, with reduced hospital admissions, short length of hospital stay and lower health-care costs all associated with dying at home.[10–14]

The quality of care at the end of life is not only concerned with where people die, but also it is related to the preferred PoD and how people's preferences are met when they are approaching the end of their life.[15] Evidence shows that the majority of people prefer to die at home, followed by a preference for hospice or residential home, with hospital being the least-preferred PoD.[16,17] However, hospital remains the most common PoD in most regions.[18] This is despite England being the country considered to be at the top of the quality-of-death ranking.[19]

Place of death in England has been described at a population level in many different ways and from various angles, but most analyses are focused on a specific cause of death (CoD), are largely descriptive and cover only a short time period,[20–22] limiting the comparability and interpretability of the research findings. Death registration data provide the most comprehensive record of deaths registered so far within each region. In England (and Wales), deaths should be registered within 5 days of the death occurring. Although there are some situations that result in death registration being delayed (e.g. if a death is unexpected, accidental or suspicious and is referred to a coroner for investigation), if analysing annual trends from non-external causes then the impact of delays to death registration is minor.[23]

Temporal patterns in mortality are well recognised in a wide range of diseases. A Hong Kong-based study demonstrated that the effects of influenza on mortality were higher in winter and late spring/early summer than in other seasons. This two-peak pattern of seasonal effects on influenza was found for cardiorespiratory disease and subcategories pneumonia and influenza, chronic obstructive pulmonary disease (COPD), cerebrovascular diseases (CBDs) and ischaemic heart disease as well as for all-cause deaths.[24] Studies from England found that excess winter death (EWD) had clear seasonal patterns in deaths related to the following conditions: circulatory, coronary heart disease, stroke, respiratory, influenza and pneumonia or chronic lower respiratory diseases.[25,26] Increased risk of death has also been reported in relation to some specific time periods, for example when trainee/inexperienced doctors are on duty, at the weekend, and across the Christmas and New Year periods.[27–29] These studies confirm the presence of the temporal patterns in deaths; however, to our knowledge, no study has examined whether or not and how these patterns are affecting end-of-life care.

There are four basic health-care models in the world: the Beveridge model, the Bismarck model, the National Health Insurance model and the out-of-pocket model.[30] England represents the Beveridge model, in which health care is provided and financed by the government through tax payments. England is also the pioneer of hospice care. Therefore, a full review of PoD in England will provide important data on the quality of end-of-life care, identifying the gaps and the best way forward through contrasting information from various perspectives, for example regional and temporal variations, not only useful for England, but also relevant in international contexts. Understanding regional variation is useful for setting up priority agendas, identifying service gaps and informing resource allocation; the temporal variation is of particular value in making our service more responsive to service user's needs, and understanding better variations in demanding, and more effectively using, existing health-care resources.

This report has been produced to describe the variations in PoD, and the factors that affect these, in order to improve the quality of care at the end-of-life and to enable more patients to die in their preferred PoD. The main objectives of this report are to (1) describe PoD in England by demographic, socioeconomic and temporal variables; (2) determine how much of the variation in PoD can be explained by potential explanatory variables at the area level, and building on this to develop individual-level multivariable regression models; and (3) evaluate factors associated with PoD and to construct risk assessment models to inform practice. The analysis has been run separately for the following seven defined causes of deaths: all causes, non-cancer, cancer, cardiovascular diseases (CVDs), CBDs, neurological conditions and COPDs.

Chapter 2 Methods

Data source

The death registration data collected by the Office for National Statistics (ONS) constitute the main data source for this report. Death registrations are widely recognised and used as a reliable data source to study and monitor the PoD in society. Death registration is the legal recording of all deaths in England and Wales. By law in England, a death must be registered within 5 days of its occurrence, although this period may be extended in certain circumstances, i.e. when a death is referred to a coroner. The death must be registered by a qualified informant and this person must be one of the following: (1) a relative, usually the closest; (2) someone who was present at the death; (3) someone who is instructing the funeral director; or (4) another person may qualify as an informant (in rare circumstances). It is possible to register the death as soon as the informant has obtained either a 'Medical Certificate of Death' from the hospital/doctor or a Form Part B from the coroner's office, the only exception being when an inquest is being held. In this case the registration of death will occur only once the coroner has given his/her permission. A death can be registered only in the registration district in which the death occurred.

The death registration data reviewed in this report were based on the details collected after deaths have been certified and registered. There are some situations that resulted in the registration of the death being delayed. Those deaths referred to coroners may take many months or even years to be registered, and the ONS is not notified that a death has occurred until it is registered. Therefore, the death registration data collected by the ONS can only capture the deaths that are registered in a particular period, rather than the number of deaths that actually occurred in that period.

However, the cases of delays in death registration account for only a small minority of all deaths. For example, in 2011 there were 484,367 deaths registered in England and Wales, of which 463,450 occurred in 2011, representing 95.7% of the deaths registered; the proportion of registered deaths compared with those that occurred varies in terms of the underlying CoD.

In 2011, except for the causes of death [pregnancy, childbirth and the puerperium (chapter 15); external causes of morbidity and mortality (chapter 20)],[31] the proportion of deaths registered in the same year as they occurred was consistently above 90% in all other causes of death. A further breakdown shows 98.1% for neoplasms, 96.1% for the nervous system, 97.1% for the circulatory system, and 96.6% for the respiratory system.[23]

The information contained in the ONS database includes details from the death certificate: PoD, the deceased's usual residential address, gender, date of death, date of birth, country of birth, the deceased's occupation, marital status, informant relationship, underlying CoD and any mentioned CoD. Information on derived area-level variables based on place of usual residence, for example area-level deprivation indicator, local authority (LA) and primary care organisation (PCO) were also available. Prior to 2001, the CoD was coded according to the Ninth Revision of the *International Classification of Diseases* (ICD-9);[32] from 2001, deaths were coded using the Tenth Revision of the *International Classification of Diseases* (ICD-10).[31]

The CoD recorded on the death certificate consists of two parts: Part I and Part II. Part I is used to show the immediate CoD and any underlying cause or causes. Part II is used for any significant condition or disease that contributed to the death but which is not part of the sequence leading directly to death. In the death registry database, an underlying CoD is accompanied by a varied number of causes of death mentioned on the death certificate. The rules of determining the underlying CoD have been changed over time, introducing challenges to the interpretation of the data particularly for the time trend analysis. The rule changes mainly concern the method of selecting the underlying CoD, which has a different impact on disease-specific mortality statistics.[33]

Study sample, design and settings

This is a population-based cross-sectional study. All deaths registered between 1984 and 2010 in England were included in the data set ($n = 13,264,769$) but excluding the following two groups: (1) all external causes of death, and (2) all of those who died at the age of ≤ 24 years, which, in total, account for 0.83% of all deaths. The focus on non-external causes of death is driven by the fact that these are the deaths that could have potentially benefited from palliative and end-of-life care planning. Children and young people have very different end-of-life care needs, so have been excluded to maintain sample homogeneity.[34]

Outcome variables

The outcome variable was the PoD. The classification of the PoD was different according to the time period, detailed as below:

1. *From 1984 to 1992* There were four categories, consisting of hospital, own home, other communal establishment and elsewhere. Hospitals included UK NHS and non-NHS non-psychiatric and psychiatric hospitals, and NHS and non-NHS nursing homes. 'Hospice' was not classified as a separate category but was usually included as a nursing home in the hospital category. 'Other communal establishment' comprised non-hospital communal places (e.g. residential home, social services home). All other deaths in places not included in the listed categories were grouped into 'elsewhere'.
2. *From 1993 to 2010* There were six categories, comprising hospital, own home, hospice, care home (including residential homes with and without nursing), other communal establishment and elsewhere. The proportion of hospital deaths in this period was therefore smaller than the earlier period, as hospice and nursing homes were counted separately. Accordingly, the proportion of deaths in 'other communal establishment' was also smaller, as these previously were communal places excluding care home with nursing.

In both periods, we grouped psychiatric hospitals with all other hospitals, as we assume that both types of hospitals had similar facilities for end-of-life and palliative care. We did not have sufficient information to identify the deaths that happened in palliative care wards within a hospital. Therefore, a death that occurred in hospital palliative care ward was counted as the death in hospital.

Explanatory variables

Two types of explanatory variables have been used for this analysis: individual level and area level. Individual-level variables included age, gender, underlying CoD, marital status, year of death, and the location of usual residence. Area-level variables were obtained through record linkage of the usual residence at the lower layer super output area (LSOA) level or other appropriate geographic boundaries. LSOAs are a geographic boundary designed to improve the reporting of small area statistics in England and Wales. Each LSOA has an approximately similar population size, ranging from 1000 to 3000 (average 1500) and contains 400–1200 households. There are a total of 32,482 LSOAs in England. LSOA boundaries have been subject to minor changes over time. The impacts and implications of these changes on this analysis are varied depending on purposes.[35]

Age was predominantly analysed as a categorised variable in five groups: 25–54, 55–64, 65–74, 75–84 and 85+ years. The grouping took into account the commonly used age cut-off values to facilitate cross-study comparisons, and also the usefulness for policy development and targeting improvement. Gender was a binary variable (female vs. male).

The underlying CoD was classified into seven classes: all CoDs, excluding external CoDs; all non-cancer CoD; cancer; CVDs, CBDs, neurological conditions and COPDs. The *International Classification of Diseases* (ICD) codes used to identify these causes of death are listed in *Table 1*.

We planned to use the 'country of birth' variable but, when we looked into the details of this variable, we found coding inconsistencies that made its use problematic. The main problems were:

1. No country of birth information for pre-1988 data.
2. Pre- and post-1993 had substantially different recording schemes – the pre-1993 scheme had only 100 distinct codes recording country of birth, whereas the post-1993 scheme had a much more detailed set of country of birth codes, making the grouping and comparability with the earlier period significantly compromised.
3. Post-1993 codes were also problematic. In 2006, there was a coding scheme change by the ONS, with some codes in earlier periods overlapping with the later periods. For example, 012 was 'Austria' in the old scheme but was defined as 'Algeria' in the new scheme; 090 was 'Hong Kong' before and then as 'Solomon Islands' after. This made the 2006 data unusable.

Furthermore, there was a very imbalanced distribution of the country of birth variable across different disease groups. In some subgroup analysis it was hard to make sense or maintain statistical efficiency if we were to keep this variable as an explanatory variable. Therefore, we decided to use this section of information only in a specific subgroup analysis (see *Appendix 2*, *Conferences abstracts and presentations*, item 10).

Notwithstanding the difference in pre- and post-coding schemes, the data show that those who died in the study period were predominantly born in the UK (overall 91.3%; range 91.1% to 96.3%). On average, the pre-1993 coded data produced a consistently higher proportion of UK-born deaths than the post-1993 scheme (96.1% vs. 92.7%), suggesting a systematic discrepancy between the two coding systems. However, we acknowledge that the pre- and post-1993 difference may partly reflect a genuine consequence of changing levels of immigration over the middle decades of the twentieth century. We also tested the disease-specific distribution of the country of birth using the 2007–10 data. Post-1993 data also showed that 92.8% of those who died were born in the UK.

For the aforementioned reasons and findings from the empirical data, we do not feel there was merit to include this variable in the standard set of explanatory variables in the report. After consulting and discussing with the Project Advisory Group and the project team members, we decided to separately analyse the 'country of birth' variable in a subanalysis, through which we investigated the PoD with a special focus on ethnicity. To allow for full-scale exploration of the ethnicity issue, we chose London – a metropolitan city with high ethnic diversity – as the primary study sample (see *Appendix 2*, *Conferences abstracts and presentations*, item 10).

TABLE 1 *International Classification of Diseases* codes used to identify causes of deaths

CoD	ICD-9 (1984–2000)[32]	ICD-10 (2001–10)[31]
All excluding external	001–799	A00–R99
All cancer	140–209	C00–C97
All non-cancer	All excluding 140–209	All excluding C00–C97
CVDs	390–429, 440–456	I00–I52, I70–I99
CBDs	430–439	G45-G46, I60–I69
Neurological conditions	330–337, 340	G35–G37, G20, F02.3, G12
COPDs	490–492, 494–496	J40–J44, J47

Marital status was included as an individual-level variable and grouped into five classes: married, widowed, divorced, single, and not stated or unknown. Marital status was not available in the data before 1988, and before 1993 the variable was not consistently coded, therefore analysis using this variable was carried out only for post-1993 data. Year of death was directly extracted from the date of death, as recorded on the death registration record. This was therefore the year that the death occurred.

The location of usual residence was used to derive in which health authority region the deceased had lived: North East, North West, Yorkshire and the Humber, East Midlands, West Midlands, East of England, London, South East Coast, South Central and South West.

An area-level variable – the Index of Multiple Deprivation (IMD) – was used in this report as a proxy measure of socioeconomic status (SES). The IMD is a measure of multiple deprivation for small areas in England.[36] Four versions of the IMD have been developed over the study period: IMD 2000, IMD 2004, IMD 2007 and IMD 2010. The IMD 2000 was measured at ward level, whereas the other IMD versions were measured at the LSOA level. The IMD is a composite of domains related to different aspects of deprivations. The IMD 2000 was based on six domains (income; employment; health deprivation and disability; education, skills and training; housing; geographical access to services). The later versions of the IMD were based on a consistent seven domains: income; employment; health and disability; education, skill and training; barriers to housing and services; living environment; and crime. A higher score in the indices indicates a higher level of deprivation. The areas were ranked by the IMD score and split into quintile groups (1 = most deprived, 5 = least deprived). Although the original area-specific composite scores of the IMD may have changed over time, the change in the quintile ranking score was not significant. There were significant changes in IMD ranking between IMD 2000 and the later versions of IMD; however, the IMD ranking movement was minimum between IMD 2004, IMD 2007 and IMD 2010 (*Table 2*). Therefore, we used IMD 2000 for the 1984–2000 data and IMD 2010 for the 2001–10 data.

We derived two temporal variables for this report: seasonal period (spring, summer, autumn, winter) and holiday period (Christmas, New Year and Easter). The seasonal period was defined by month of death according to the following cut-off: spring (March to May), summer (June to August), autumn (September to November) and winter (December to February). The Christmas, New Year and Easter holiday periods were defined as 3 days before and after the specified holiday. For example, a Christmas period was 3 days before and after 25 December, totalling seven calendar days (1 week). Weeks outside the holiday periods were defined as a normal period.

The pre-1993 data did not have the 'informant relation' variable, whereas 10.3% of the post-1993 death records had a 'missing' value for this variable. The 'informant relation' was noted in the database as 'loosely coded' short text, and therefore had little value as a proxy for indicating the social support of the deceased. There was no further information in the database available to compensate this. Therefore, we decided not to use 'informant relation' in this report.

TABLE 2 Change of the LSOA quintile score (%) in IMD 2004, IMD 2007, IMD 2010 ($n = 32{,}482$)

Quintile score	IMD 2000	IMD 2004	IMD 2007	IMD 2010
IMD 2000	–	55	56	57
IMD 2004	12.7	–	19	24
IMD 2007	13.7	0.1	–	17
IMD 2010	14.8	0.3	0.0	–

Percentages in the table represent the LSOAs that have changed at least one quintile ranking; the shaded cells indicate the LSOAs that have changed at least two quintile rankings.

Statistical analysis

Before the analysis, data were checked for completeness, problems and errors. Records with missing, illogical and invalid values on aforementioned variables were deleted. These included illogical range of data values, for example age > 300 years, year of death outside 1984–2010, month of death > 12 or < 1 and missing data on PoD.

Data were described for their characteristics, mainly using frequency, percentage and 95% confidence interval (CI). Continuous data were categorised as a categorical variable but also estimated for mean, median, standard deviation (SD) and range. The data were described for all listed causes of death in *Table 1*. The bivariate relationship between explanatory variables and PoD was plotted using appropriate graphs and the difference across groups was investigated using Pearson chi-squared statistics. The regional variation in PoD was displayed using geographic information system (GIS). PoD was described as a four- or six-category variable, depending on the time period.

Variations in PoDs at the aggregate LSOA level were analysed and modelled using a weighted linear regression model. The dependent variable was the area-specific percentage of hospital deaths, with the total number of deaths at the selected area level as one of the adjusted variables. The proportion that can be explained by the model was derived from the model and measured by a R square. The explanatory variables were derived from the data and introduced into the models as the percentage of defined subcategory (e.g. percentage female) or the average value for continuous data (e.g. age). The models were constructed using the data for the 1993–2010 period, as there were a limited number of demographic variables for the period 1984–92, and the geographic boundaries had changed significantly from the earlier period to the later periods. The explanatory variables included average age, percentage male, percentage married, year of death, average IMD score, percentage winter deaths or percentage deaths in the Christmas period. Area was defined at the PCO and LA levels, and modelled separately.

Factors associated with PoD were investigated using binomial regression models, or modified Poisson regression models in the case of convergence problem.[37,38] The dependent variable was a binary indicator of PoD. We considered the least preferred PoD [hospital (1)] compared with the number two or number three most common places of death (0), which was determined by the CoD of interest. All selected independent variables, as informed by the area-level modelling analysis and also checks for multicollinearity using variance inflation factor, were forced to stay in the model to adjust for potential confounding effects. The top three factors most strongly and significantly associated with PoD were tested for significance of the two-way interaction effects. The interaction effect was introduced into the model as a multiplicative term (e.g. age*cancer, age*marital status*cancer) along with the main effects. The prevalence proportion ratio, referred to in this report as proportion ratio (PR), derived from the multivariable models, was used to measure the strength of the association. The PR is a more appropriate relative risk measure than the widely misused odds ratio (OR); the latter tends to overestimate effect size, particularly when the outcome event of interest is common (≥ 10%).[39]

We also constructed individual-level risk assessment models for listed CoDs, to assess an individual's risk of dying in the hospital or non-hospital settings. A non-hospital was a place other than a NHS- or non-NHS hospital. Given the changing patterns we have found in a recently published study on cancer deaths in England,[18] we used the recent 2006–9 data as the training set to build the model, and its predictive performance was tested using the 2010 data (validation set).

The model construction followed similar procedures, using binomial models or Poisson regression models in case of convergence problem of the former. Individual-level geographical and temporal variation modelling analysis involved additional steps to include all of the statistically significant or practically meaningful interaction effects. We used a stepwise selection method to select variables to be included in the final risk assessment model.[40] All variables or interaction terms that stayed in the final model needed to have a p-value of < 0.05 in the type 3 score statistics test.[41] Where possible, continuous variables were introduced, as this was found to be a more efficient way of using the available information.[42–46] We did not test for collinearity, as the primary concern for the model building was the prediction of accuracy for the risk of dying in hospital compared with a non-hospital setting.[47] The model performance validation was evaluated using (1) a Wald chi-squared test and (2) the area under the receiver operating characteristic curve (AUC) and its 95% CI. The AUC is a widely used statistical measure for assessing the discriminatory capacity of a predictive model. It represents the overall accuracy of the model, independent of the cut-off value. The AUC range goes from 0.5 to 1, with 0.5 showing no discrimination and being equivalent to coin tossing; an AUC value of 0.7 indicates good discriminating ability.[48]

All analysis was carried out separately for all causes, non-cancer, cancer, CVD, CBD, neurological conditions and COPD. As this study is exploratory in nature, we did not adjust *p*-values for multiple testing. A *p*-value of < 0.05 is considered to be statistically significant. Data manipulation and statistical analysis were implemented by SAS 9.3 (SAS Institute Inc., Cary, NC, USA). Graphical presentations were completed by R 3.0.0 (The R Foundation for Statistical Computing, Vienna, Austria) and SAS 9.3.

Ethics

All analyses were based on fully anonymised patient-level records; therefore, no ethical approval was required according to the Information Commissioner's Office guidelines, ONS procedures and those of the King's College London's (KCL) Research Ethics Committee. We have obtained an ethical clearance letter from the KCL ethics office. Following ONS procedures, a data access agreement was signed by both parties (researchers and ONS), and copies of all required forms were provided in a formal agreement of data management and protection for the project. Individual members of the project team had data access approvals from ONS.

Chapter 3 Results

Characteristics of the study sample

In total, 1716 (0.037%), 1471 (0.037%) and 1535 (0.034%) records with missing, illogical and invalid values on the standard sets of variables were deleted in periods of 1984–92, 1993–2000 and 2001–10, respectively. From 1984 to 2010, there was a total of 13,154,705 deaths (*Table 3*). The average annual death remained relatively stable at around 500,000 before 2001 but with a declining trend in the most recent 10-year period ($n = 456,770$). People died at an increasingly older age, with average age at death of 75.3 years in 1984–92, 76.8 years in 1993–2000, and 77.9 years in 2001–10. The proportion of those who died at > 75 years increased from 58.2% in 1984–92 to 67.9% in 2001–10. Slightly more women than men died in the study period (52.4% vs. 47.6%). CVDs were the most common CoD before 2001 (34.5%) but were overtaken by cancer (27.8%) and became the second most common CoD (26.9%) in the most recent 10-year period. CBD deaths also showed an overall reducing trend (12.7% in 1984–92, 10.4% in 2001–10). Those who were 'widowed' made up the largest proportion of the deceased (43.8%). 'Married' people accounted for around two in five deaths (40.2% and 38.5% in 1993–2000 and 2001–10, respectively).

TABLE 3 Characteristics (%) of patients from all causes of death, England 1984–2010

Variable	Value	1984–92	1993–2000	2001–10
All	All	4,588,315	3,998,686	4,567,704
Age, years (continuous)	Mean (SD), median (min., max.)	75.3 (11.9), 77 (25, 114)	76.8 (12.4), 79 (25, 116)	77.9 (12.9), 80 (25, 115)
Age, years (categorised)	25–54	5.7	5.8	5.9
	55–64	11.4	8.8	8.8
	65–74	24.6	21.9	17.4
	75–84	36.1	34.3	33.4
	85+	22.2	29.3	34.5
Gender	Male	48.5	47.3	47.1
	Female	51.5	52.7	52.9
Cause of death	Cancer	25.9	25.5	27.8
	CVDs	36.5	32.5	26.9
	CBDs	12.7	10.8	10.4
	COPD	5.0	4.8	5.1
	Neurological conditions	1.5	1.2	1.4
	Other	18.5	25.1	28.5

continued

TABLE 3 Characteristics (%) of patients from all causes of death, England 1984–2010 (*continued*)

Variable	Value	1984–92	1993–2000	2001–10
Marital status	Married	NA	40.2	38.6
	Widowed	NA	43.9	43.7
	Single	NA	10.0	9.6
	Divorced	NA	5.1	7.5
	Unknown	NA	0.8	0.7
IMD	1 (most deprived)	32.0	30.0	21.3
	2	22.5	22.4	20.7
	3	17.5	18.2	21.0
	4	14.4	15.0	19.9
	5 (least deprived)	13.5	14.4	17.1
Region	North East	6.0	5.8	5.7
	North West	15.7	15.2	14.9
	Yorkshire and the Humber	10.8	10.5	10.6
	East Midlands	8.1	8.4	8.8
	West Midlands	10.6	10.8	10.9
	East of England	9.8	10.3	11.0
	London	13.2	12.2	10.9
	South East Coast	9.1	9.2	9.1
	South Central	6.4	6.8	7.0
	South West	10.4	10.8	11.2
Temporal				
Season	Spring	25.5	24.6	25.3
	Summer	22.5	22.5	22.9
	Autumn	23.6	23.9	23.9
	Winter	28.4	29.0	27.9
Holiday period	Christmas	2.3	2.4	2.2
	New Year	1.3	1.6	1.4
	Easter	1.9	1.9	1.9
	Normal	94.5	94.1	94.5
PoD	Hospital	64.7	55.0	57.3
	Home	24.1	20.4	19.0
	Hospice	NA	4.1	5.1
	Care home	NA	18.2	17.2
	Other communal establishment	7.1	0.3	0.1
	Elsewhere	4.0	2.0	1.3

Max., maximum; min., minimum; NA, not available.

Deaths were clustered around the more deprived end of the population before 2001 (53.5% below the second quintile); however, the deceased were more evenly distributed across IMD quintiles between 2001 and 2010 (ranging from 17.1% to 21.3%). The regional distribution of deaths was broadly representative of the underlying population structure.[49] Deaths in winter accounted for the highest number of deaths, whereas summer had the lowest number of deaths. Christmas had higher-than-average proportions of deaths (2.3% vs. 1.9% in normal periods, given 52.1775 weeks in 1 year); the pattern remained similar throughout the study period. Hospital, home and care home were the three most common places of death; the deaths in hospital accounted for nearly three times the number of deaths at home or in care homes. From 1993 to 2010, although there was a slight increase in hospital deaths (55.0–57.3%) and a reduction in both home (20.4–19.0%) and care home deaths (18.2–17.2%), there was a nearly 25% increase in hospice deaths (4.1–5.1%).

People who died from cancer were the youngest, at 71.8 years, throughout the study period; CBDs had the oldest average age at death of 80.3 years among the selected causes of death (*Tables 4–9*). Although most CoDs showed a pattern of increasing age at death, neurological conditions showed a decrease from 1993 to 2010 (78.2 years in 1993–2000 to 76.3 years in 2001–10). The proportion of those who died at > 75 years varied across CoDs, with cancer having the lowest (51%) and the CBDs the highest (82%) in 2001–10. More men died from cancer, CVDs and COPD than women, whereas the deaths from non-cancer, CBDs and neurological conditions had an overall opposite gender profile. The deaths from neurological conditions showed a distinct pattern from other CoDs, with more men than women dying from this condition in 2001–10 (53.9% vs. 46.1%) and more women dying in earlier years.

Although over half of those who died from cancer were married, nearly half of patients dying from a non-cancer cause were widowed (47.9% and 48.5%); this remained the case for the other CoDs as well. Patients with COPD were more likely to live in the most deprived areas, although this had significantly reduced from 38.3% before 2001 to 28.7% after 2001. Other CoDs were more evenly distributed across the IMD quintiles. The regional distributions of deaths were following the pattern seen in the data for all of CoDs combined.

The EWDs were more pronounced in non-cancer causes, particularly in COPD: nearly one in three deaths occurred in winter, although the unequal distribution across seasons improved over time with the lowest at 19.2% and 20.1% in summer and 36.4% and 32.7% in winter for 1993–2000 and 2001–10, respectively. Deaths during Christmas were highest across the CoDs, again, COPD deaths were more likely to happen during the Christmas period (2.8–3.4%). The combined total deaths in holiday period were highest for COPD (6.7%) and lowest for cancer (5.0%). New Year had lower than average deaths irrespective of the CoD.

Place of death varied by CoD. Hospital was the most common PoD regardless of the underlying CoD. Neurological conditions had the lowest rate of hospital deaths (46.1% in 2001–10), whereas COPD deaths most commonly occurred in hospital (68.3% in 2001–10). The second most common PoD in cancer deaths was home (24.1%) but it was care home in non-cancer deaths (20.0%). In total, 27.4% of deaths from CVDs were at home but the figure for CBD deaths was only 6.7%. Neurological conditions had the highest proportion of care home deaths (35.2%); this was around 10% for the other conditions. A significant number of cancer deaths took place in hospices (17.1%). Less than 1% of deaths from the other CoDs occurred in a hospice, except for neurological conditions, which were the second largest group to most commonly die in a hospice (3.5%).

TABLE 4 Characteristics (%) of patients from non-cancer causes of death, England 1984–2010

Variable	Value	1984–92	1993–2000	2001–10
All	All	3,401,254	2,978,318	3,299,694
Age, years (continuous)	Mean (SD), median (min., max.)	76.8 (11.5), 78 (25, 114)	78.5 (11.9), 81 (25, 116)	79.8 (12.6), 82 (25, 115)
Age, years (categorised)	25–54	4.3	4.6	5.0
	55–64	9.2	6.7	6.4
	65–74	22.3	19.1	14.2
	75–84	37.9	35.2	33.3
	85+	26.3	34.4	41.0
Gender	Male	47.2	45.6	45.1
	Female	52.8	54.4	54.9
Marital status	Married	NA	35.8	33.4
	Widowed	NA	47.9	48.5
	Single	NA	10.6	10.2
	Divorced	NA	4.8	7.1
	Unknown	NA	0.8	0.7
IMD	1 (most deprived)	32.0	29.9	21.5
	2	22.6	22.5	20.9
	3	17.6	18.3	21.1
	4	14.4	15.0	19.8
	5 (least deprived)	13.4	14.3	16.7
Region	North East	5.9	5.7	5.6
	North West	15.8	15.2	14.9
	Yorkshire and the Humber	10.9	10.5	10.6
	East Midlands	8.1	8.4	8.8
	West Midlands	10.6	10.8	11.0
	East of England	9.7	10.3	11.0
	London	13.1	12.2	10.9
	South East Coast	9.2	9.2	9.2
	South Central	6.3	6.8	6.9
	South West	10.5	10.8	11.2

TABLE 4 Characteristics (%) of patients from non-cancer causes of death, England 1984–2010 (*continued*)

Variable	Value	1984–92	1993–2000	2001–10
Temporal				
Season	Spring	25.7	24.6	25.5
	Summer	21.7	21.7	22.2
	Autumn	23.1	23.4	23.5
	Winter	29.5	30.3	28.9
Holiday period	Christmas	2.4	2.6	2.3
	New Year	1.4	1.7	1.5
	Easter	2.0	1.9	2.0
	Normal	94.2	93.8	94.3
PoD	Hospital	63.5	57.1	61.2
	Home	23.3	18.9	17.0
	Hospice	NA	0.3	0.4
	Care home	NA	21.2	20.0
	Other communal establishment	8.7	0.3	0.1
	Elsewhere	4.5	2.2	1.3

Max., maximum; min., minimum; NA, not available.

TABLE 5 Characteristics (%) of patients from cancer causes of deaths, England 1984–2010

Variable	Value	1984–92	1993–2000	2001–10
All	All	1,187,061	1,013,213	1,268,010
Age, years (continuous)	Mean (SD), median (min., max.)	70.7 (11.9), 72 (25, 108)	71.8 (12.2), 73 (25, 108)	73.1 (12.4), 75 (25, 109)
Age, years (categorised)	25–54	9.5	9.5	8.1
	55–64	17.7	14.8	15.0
	65–74	31.2	30.1	25.7
	75–84	31.0	31.5	33.4
	85+	10.6	14.1	17.7
Gender	Male	52.3	52.2	52.2
	Female	47.7	47.8	47.8
Marital status	Married	NA	53.1	51.9
	Widowed	NA	32.1	31.2
	Single	NA	8.2	7.8
	Divorced	NA	5.9	8.6
	Unknown	NA	0.7	0.5
IMD	1 (most deprived)	32.3	30.3	20.6
	2	22.3	22.2	20.1
	3	17.3	18.0	20.8
	4	14.4	15.0	20.3
	5 (least deprived)	13.7	14.6	18.2
Region	North East	6.1	6.1	6.0
	North West	15.2	15.1	14.8
	Yorkshire and the Humber	10.5	10.6	10.6
	East Midlands	8.0	8.4	8.7
	West Midlands	10.7	10.8	10.8
	East of England	10.0	10.4	11.0
	London	13.7	12.2	10.9
	South East Coast	9.0	9.0	8.9
	South Central	6.6	6.8	7.1
	South West	10.2	10.6	11.1

TABLE 5 Characteristics (%) of patients from cancer causes of deaths, England 1984–2010 (*continued*)

Variable	Value	1984–92	1993–2000	2001–10
Temporal				
Season	Spring	24.8	24.7	25.0
	Summer	24.7	24.9	24.8
	Autumn	25.2	25.2	25.1
	Winter	25.3	25.2	25.2
Holiday period	Christmas	2.0	2.0	2.0
	New Year	1.1	1.2	1.1
	Easter	1.8	1.8	1.9
	Normal	95.1	95.0	95.0
PoD	Hospital	68.2	48.6	47.3
	Home	26.5	24.9	24.1
	Hospice	NA	15.4	17.1
	Care home	NA	9.3	10.1
	Other communal establishment	2.8	0.2	0.1
	Elsewhere	2.5	1.6	1.2

Max., maximum; min., minimum; NA, not available.

TABLE 6 Characteristics (%) of patients from CVD causes of death, England 1984–2010

Variable	Value	1984–92	1993–2000	2001–10
All	All	1,674,385	1,301,422	1,226,845
Age, years (continuous)	Mean (SD), median (min., max.)	75.4 (11.2), 77 (25, 111)	77.0 (11.3), 78 (25, 115)	78.6 (11.9), 81 (25, 112)
Age, years (categorised)	25–54	4.6	4.4	4.6
	55–64	11.6	8.6	7.8
	65–74	26.0	23.3	17.3
	75–84	36.7	36.6	35.4
	85+	21.1	27.2	34.9
Gender	Male	52.2	51.6	51.7
	Female	47.8	48.4	48.3
Marital status	Married	NA	41.3	38.0
	Widowed	NA	43.5	44.5
	Single	NA	9.5	9.5
	Divorced	NA	4.9	7.3
	Unknown	NA	0.8	0.7
IMD	1 (most deprived)	32.2	30.4	21.6
	2	22.8	22.7	21.1
	3	17.6	18.2	21.2
	4	14.2	14.8	19.7
	5 (least deprived)	13.1	13.9	16.5
Region	North East	6.0	5.9	5.6
	North West	16.1	15.5	15.1
	Yorkshire and the Humber	11.2	10.6	10.6
	East Midlands	8.2	8.4	8.7
	West Midlands	10.6	11.0	10.7
	East of England	9.4	10.1	11.0
	London	12.7	11.9	11.2
	South East Coast	9.2	9.1	9.3
	South Central	6.1	6.5	6.7
	South West	10.4	10.9	11.1

TABLE 6 Characteristics (%) of patients from CVD causes of death, England 1984–2010 (*continued*)

Variable	Value	1984–92	1993–2000	2001–10
Temporal				
Season	Spring	25.8	25.3	25.7
	Summer	22.1	22.2	22.7
	Autumn	23.6	23.9	23.8
	Winter	28.6	28.6	27.8
Holiday period	Christmas	2.2	2.4	2.2
	New Year	1.3	1.5	1.4
	Easter	2.0	2.0	2.0
	Normal	94.5	94.1	94.5
PoD	Hospital	52.2	54.4	58.1
	Home	33.5	28.8	27.4
	Hospice	NA	0.1	0.3
	Care home	NA	12.5	11.6
	Other communal establishment	6.6	0.2	0.1
	Elsewhere	7.7	4.0	2.5

Max., maximum; min., minimum; NA, not available.

TABLE 7 Characteristics (%) of patients from CBD causes of deaths, England 1984–2010

Variable	Value	1984–92	1993–2000	2001–10
All	All	582,703	432,232	473,719
Age, years (continuous)	Mean (SD), median (min., max.)	78.8 (10.2), 80 (25, 113)	80.2 (10.6), 82 (25, 110)	81.9 (10.6), 84 (25, 111)
Age, years (categorised)	25–54	2.6	2.9	2.8
	55–64	5.8	4.6	3.9
	65–74	18.9	15.8	11.3
	75–84	42.6	38.2	35.5
	85+	30.1	38.5	46.4
Gender	Male	37.6	37.1	38.3
	Female	62.4	62.9	61.7
Marital status	Married	NA	32.9	31.9
	Widowed	NA	52.3	53.1
	Single	NA	9.9	8.7
	Divorced	NA	4.1	5.8
	Unknown	NA	0.7	0.5
IMD	1 (most deprived)	29.9	27.8	19.1
	2	22.7	22.4	20.1
	3	18.1	18.8	21.6
	4	15.2	15.9	21.0
	5 (least deprived)	14.1	15.1	18.2
Region	North East	5.9	5.7	5.5
	North West	15.7	15.5	14.9
	Yorkshire and the Humber	10.7	10.6	10.6
	East Midlands	8.2	8.4	8.5
	West Midlands	10.7	11.1	11.4
	East of England	9.8	10.3	10.8
	London	11.6	10.6	9.8
	South East Coast	9.5	9.6	9.3
	South Central	6.5	6.9	7.1
	South West	11.3	11.4	12.2

TABLE 7 Characteristics (%) of patients from CBD causes of deaths, England 1984–2010 (*continued*)

Variable	Value	1984–92	1993–2000	2001–10
Temporal				
Season	Spring	25.9	25.2	25.6
	Summer	22.1	22.4	22.4
	Autumn	23.4	23.9	23.8
	Winter	28.6	28.6	28.2
Holiday period	Christmas	2.3	2.3	2.2
	New Year	1.3	1.5	1.3
	Easter	2.0	1.9	1.9
	Normal	94.4	94.3	94.5
PoD	Hospital	78.9	64.1	64.7
	Home	9.8	7.7	6.7
	Hospice	NA	0.1	0.2
	Care home	NA	27.3	27.9
	Other communal establishment	10.3	0.4	0.1
	Elsewhere	1.0	0.5	0.3

Max., maximum; min., minimum; NA, not available.

TABLE 8 Characteristics (%) of patients from neurological disease causes of death, England 1984–2010

Variable	Value	1984–92	1993–2000	2001–10
All	All	66,968	48,454	65,418
Age, years (continuous)	Mean (SD), median (min., max.)	75.3 (12.1), 78 (25, 106)	78.2 (11.0), 80 (25, 107)	76.3 (11.9), 79 (25, 105)
Age, years (categorised)	25–54	6.7	3.9	6.3
	55–64	9.3	6.3	9.2
	65–74	22.1	19.1	19.1
	75–84	40.4	40.3	39.9
	85+	21.4	30.4	25.4
Gender	Male	47.4	46.4	53.9
	Female	52.6	53.6	46.1
Marital status	Married	NA	44.0	50.8
	Widowed	NA	42.6	34.1
	Single	NA	9.1	8.0
	Divorced	NA	3.7	6.7
	Unknown	NA	0.6	0.4
IMD	1 (most deprived)	26.5	23.7	14.8
	2	21.8	21.0	18.1
	3	18.6	19.9	21.8
	4	16.9	17.8	23.3
	5 (least deprived)	16.2	17.7	22.1
Region	North East	5.2	5.6	5.6
	North West	14.0	13.2	12.6
	Yorkshire and the Humber	10.4	10.5	9.8
	East Midlands	8.0	8.0	8.5
	West Midlands	10.2	11.1	10.4
	East of England	10.8	11.6	13.0
	London	12.9	10.1	10.0
	South East Coast	10.3	9.7	9.9
	South Central	7.3	7.8	7.7
	South West	10.9	12.3	12.5

TABLE 8 Characteristics (%) of patients from neurological disease causes of death, England 1984–2010 (*continued*)

Variable	Value	1984–92	1993–2000	2001–10
Temporal				
Season	Spring	25.1	23.7	24.6
	Summer	21.8	22.5	22.1
	Autumn	23.8	24.8	24.5
	Winter	29.3	29.0	28.8
Holiday period	Christmas	2.4	2.5	2.3
	New Year	1.4	1.4	1.4
	Easter	2.0	1.7	1.8
	Normal	94.2	94.4	94.5
PoD	Hospital	71.8	35.9	46.1
	Home	13.9	13.2	14.3
	Hospice	NA	2.3	3.5
	Care home	NA	47.6	35.2
	Other communal establishment	13.5	0.5	0.6
	Elsewhere	0.7	0.5	0.3

Max., maximum; min., minimum; NA, not available.

TABLE 9 Characteristics (%) of patients from COPD causes of death, England 1984–2010

Variable	Value	1984–92	1993–2000	2001–10
All	All	228,130	192,073	231,582
Age, years (continuous)	Mean (SD), median (min., max.)	75.7 (9.2), 76 (25, 108)	76.8 (9.1), 77 (25, 108)	78.0 (9.5), 79 (25, 108)
Age, years (categorised)	25–54	1.7	1.6	1.7
	55–64	10.1	7.4	7.7
	65–74	30.1	29.1	22.0
	75–84	41.2	41.4	43.1
	85+	16.9	20.6	25.5
Gender	Male	67.0	58.6	52.9
	Female	33.0	41.4	47.1
Marital status	Married	NA	41.5	37.5
	Widowed	NA	43.3	44.4
	Single	NA	8.0	7.5
	Divorced	NA	6.2	9.8
	Unknown	NA	0.9	0.8
IMD	1 (most deprived)	39.1	37.4	28.7
	2	22.4	22.8	23.0
	3	15.6	16.0	19.5
	4	12.0	12.7	16.4
	5 (least deprived)	10.8	11.1	12.4
Region	North East	6.6	6.6	7.0
	North West	17.9	17.8	16.8
	Yorkshire and the Humber	11.9	11.8	11.8
	East Midlands	8.1	8.1	8.5
	West Midlands	10.8	10.8	10.8
	East of England	8.5	9.0	9.8
	London	14.5	13.1	11.1
	South East Coast	7.6	7.9	8.1
	South Central	5.8	6.0	6.4
	South West	8.2	8.9	9.7

TABLE 9 Characteristics (%) of patients from COPD causes of death, England 1984–2010 (*continued*)

Variable	Value	1984–92	1993–2000	2001–10
Temporal				
Season	Spring	25.4	23.3	25.5
	Summer	19.4	19.2	20.1
	Autumn	20.9	21.1	21.6
	Winter	34.4	36.4	32.7
Holiday period	Christmas	2.8	3.4	2.8
	New Year	1.8	2.5	1.9
	Easter	2.0	1.8	2.0
	Normal	93.4	92.3	93.3
PoD	Hospital	65.9	64.8	68.3
	Home	25.0	20.3	19.2
	Hospice	NA	0.2	0.6
	Care home	NA	13.2	10.9
	Other communal establishment	6.6	0.3	0.1
	Elsewhere	2.6	1.2	0.8

Max., maximum; min., minimum; NA, not available.

Bivariate association of place of death and selected explanatory variables

The plotted bivariate associations for all causes of death are shown in *Figures 1–5*. The geographical variations in PoD for all CoDs are shown in *Figures 6–10*. We also produced similar graphs for non-cancer deaths, cancer deaths, CVD and CBD deaths, neurological condition deaths and COPD deaths (see *Appendix 1*, *Figures 18–41*). All pairwise associations were statistically significant at the level of $p < 0.001$.

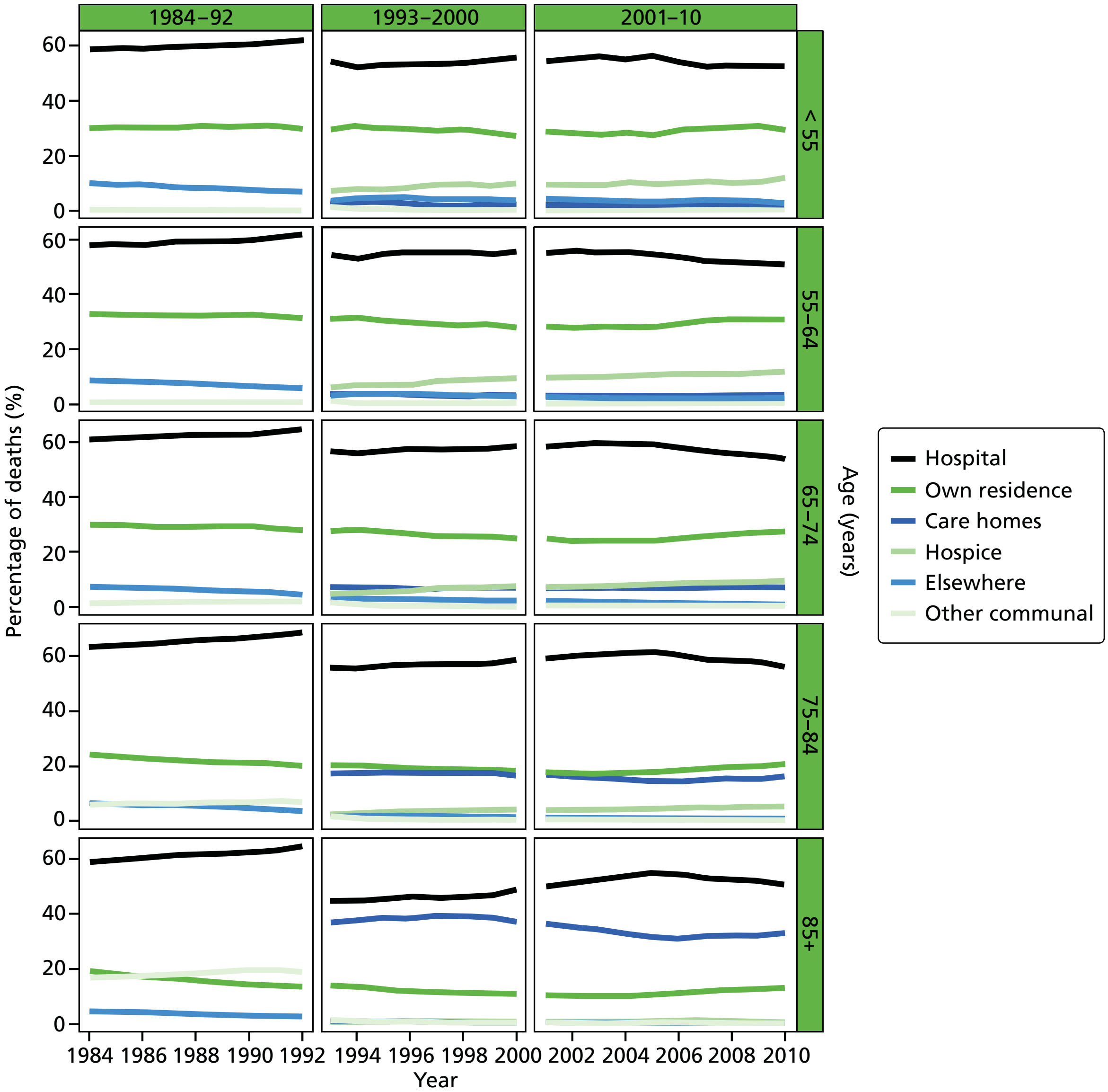

FIGURE 1 Place of death by age group in all causes of death, England 1984–2010.

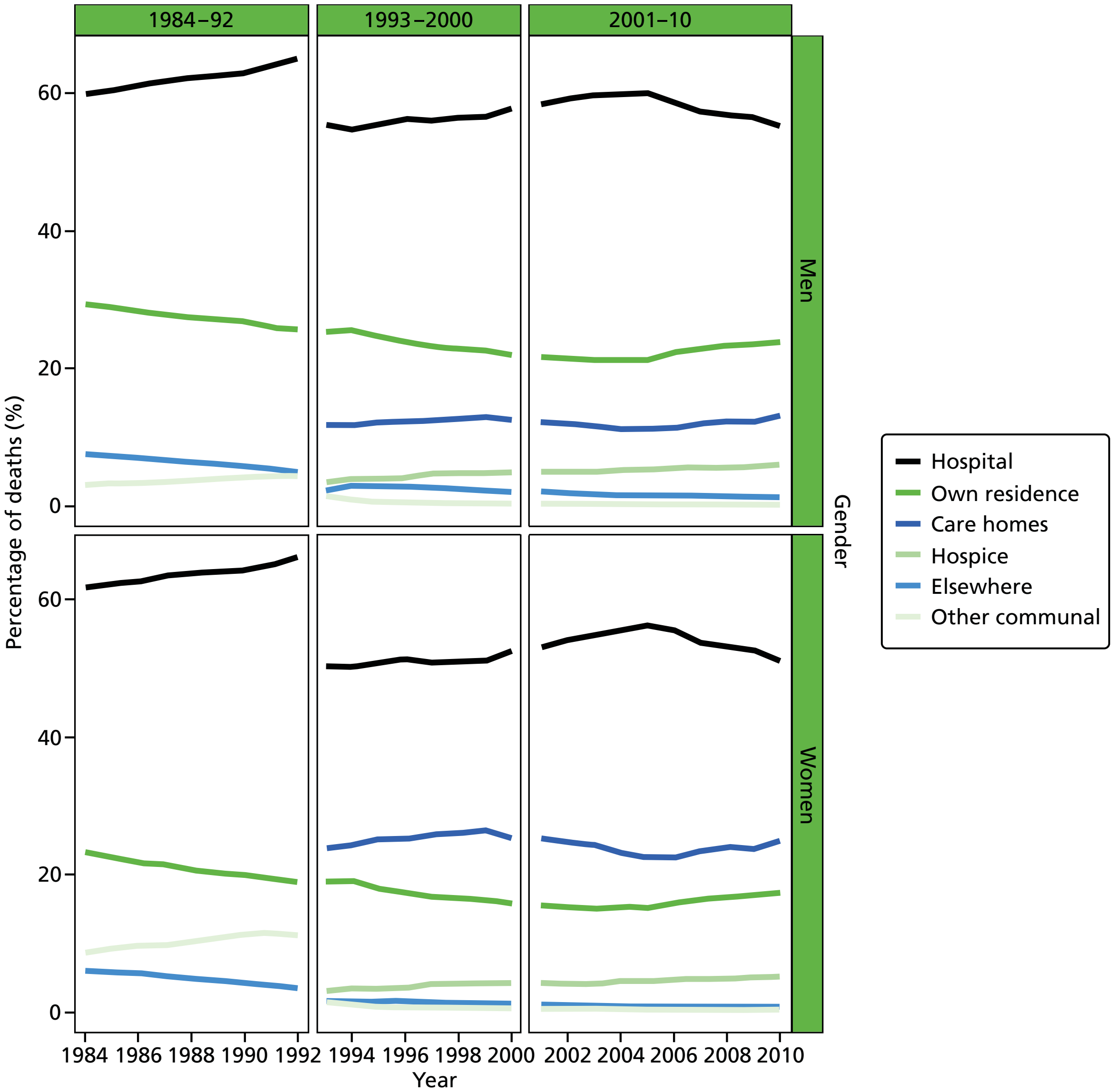

FIGURE 2 Place of death by gender in all causes of death, England 1984–2010.

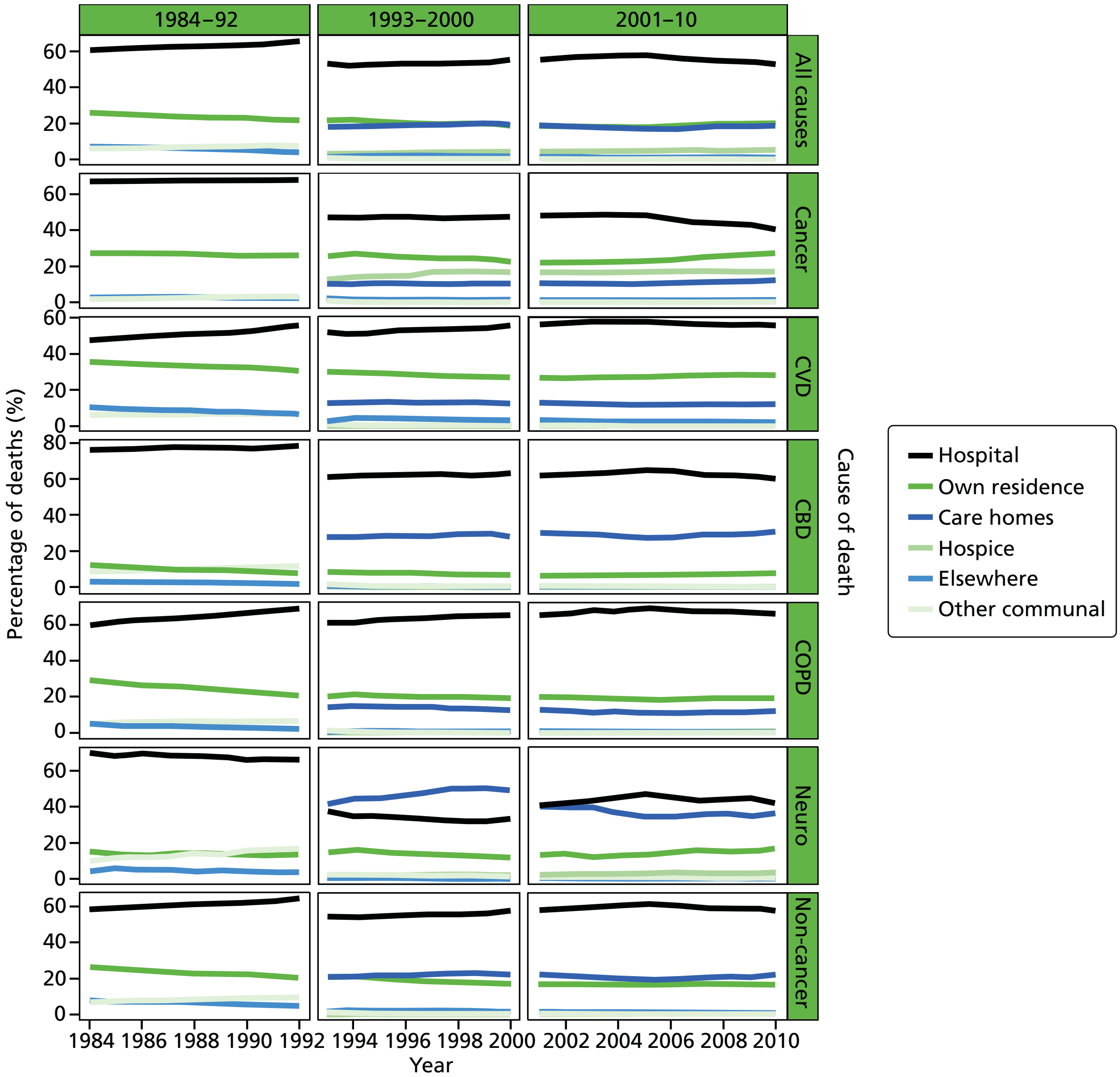

FIGURE 3 Place of death by cause of death, England 1984–2010.

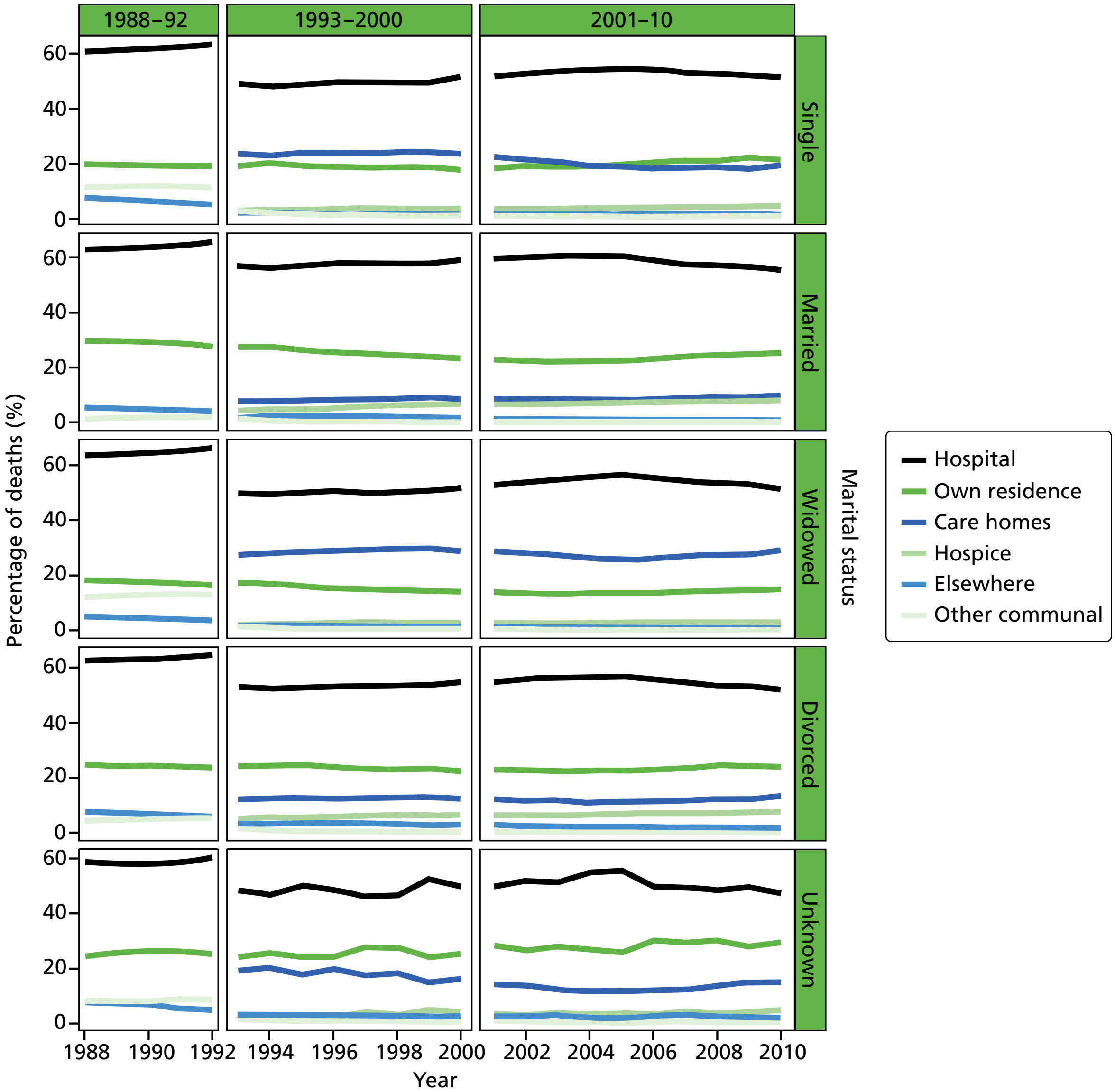

FIGURE 4 Place of death by marital status in all cause of death, England 1988–2010.

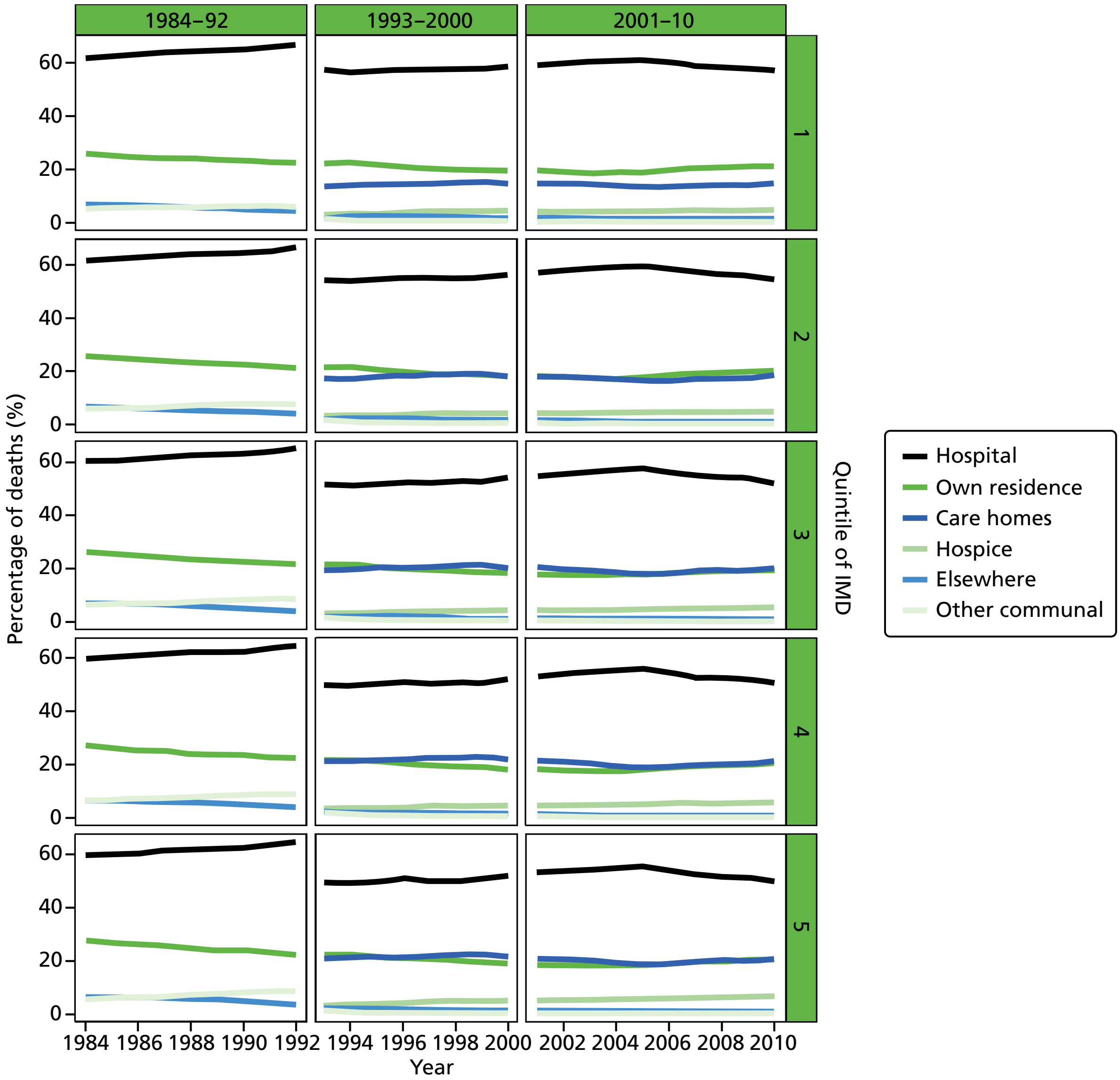

FIGURE 5 Place of death by quintile of IMD (1 = most deprived, 5 = least deprived) in all causes of death, England 1984–2010.

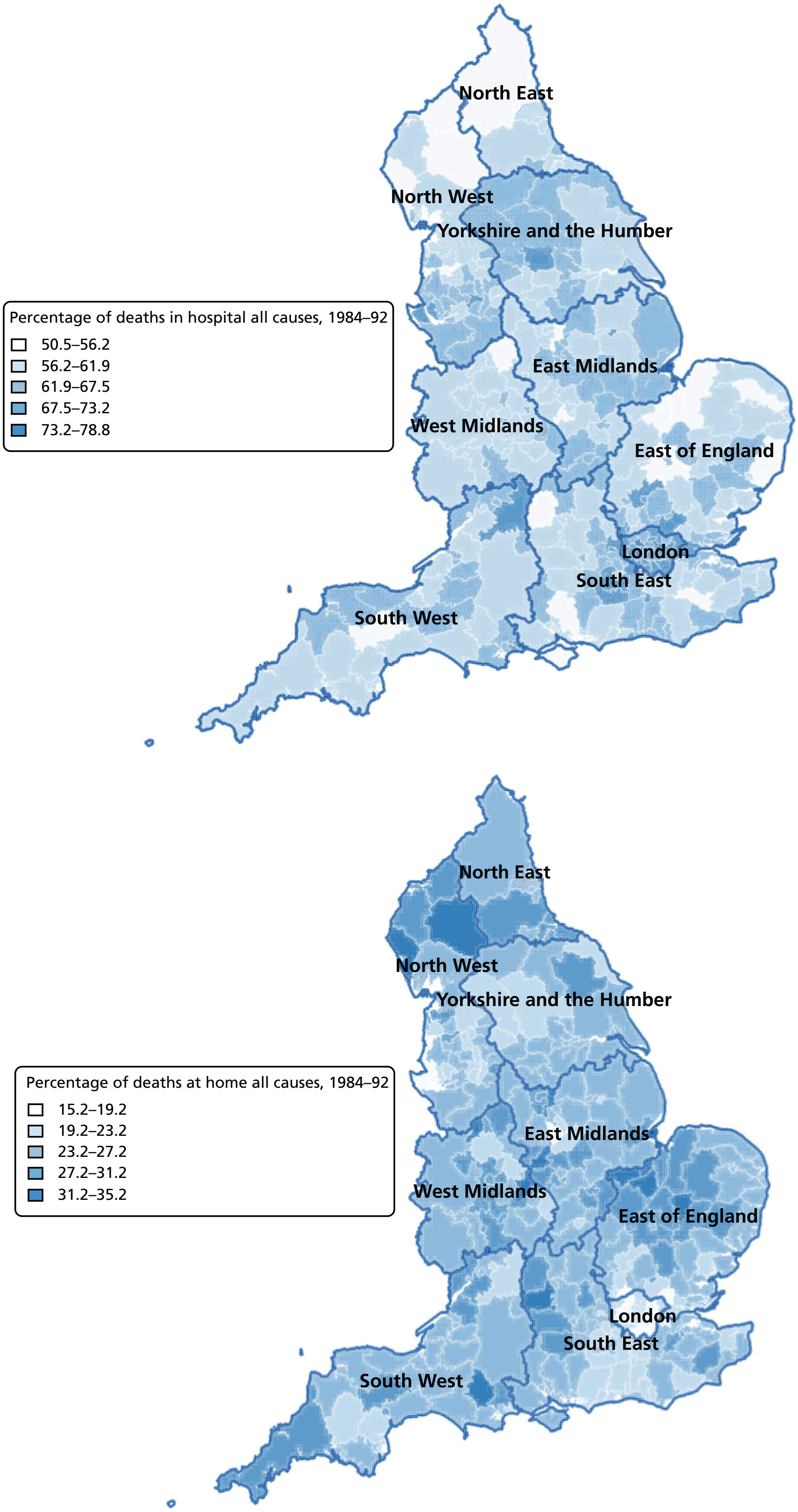

FIGURE 6 Percentage of hospital (a) vs. home deaths (b) for all causes combined by geographical areas, England 1984–92.

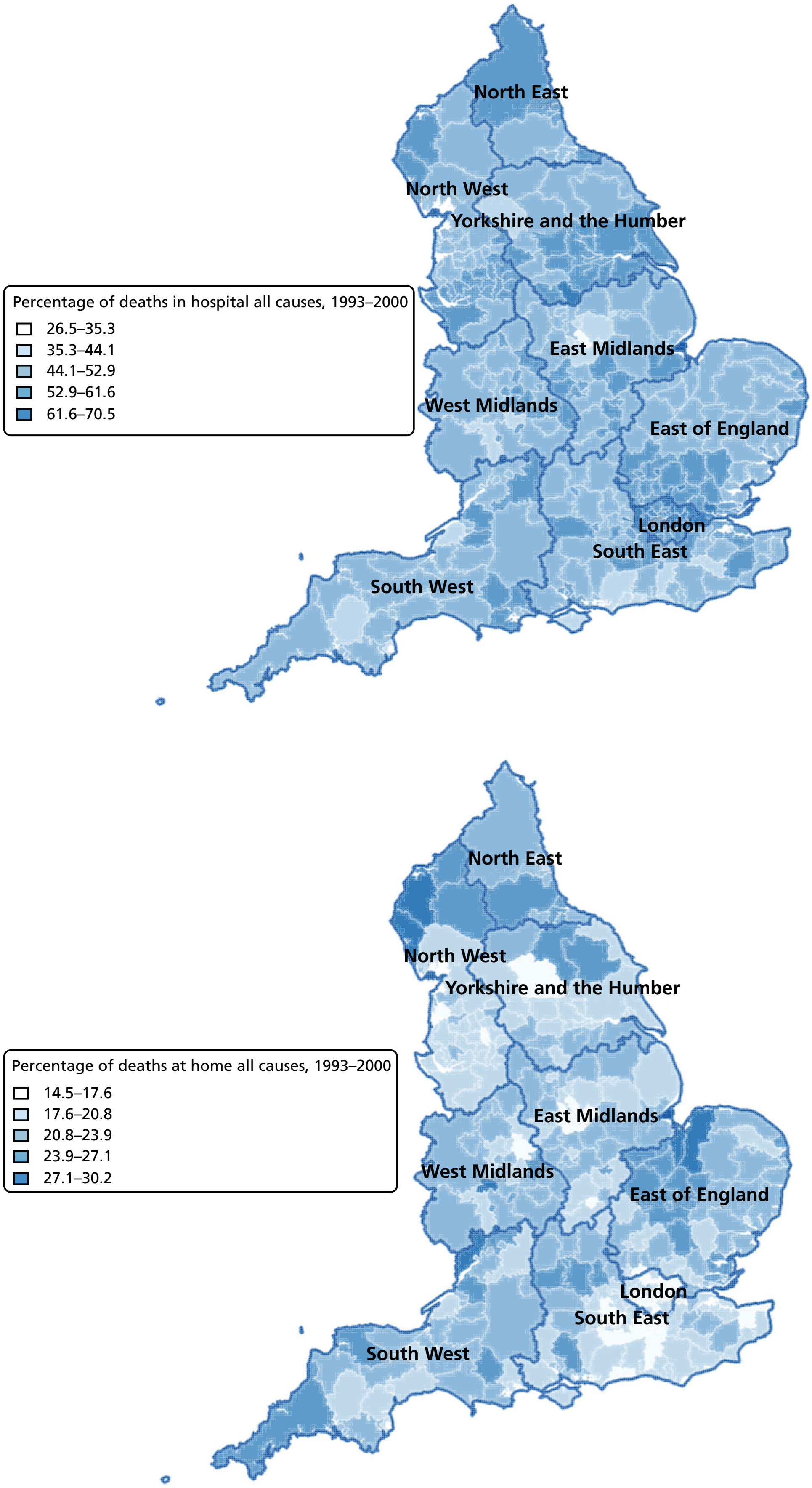

FIGURE 7 Percentage of hospital (a) vs. home deaths (b) for all causes combined by geographical areas, England 1993–2000.

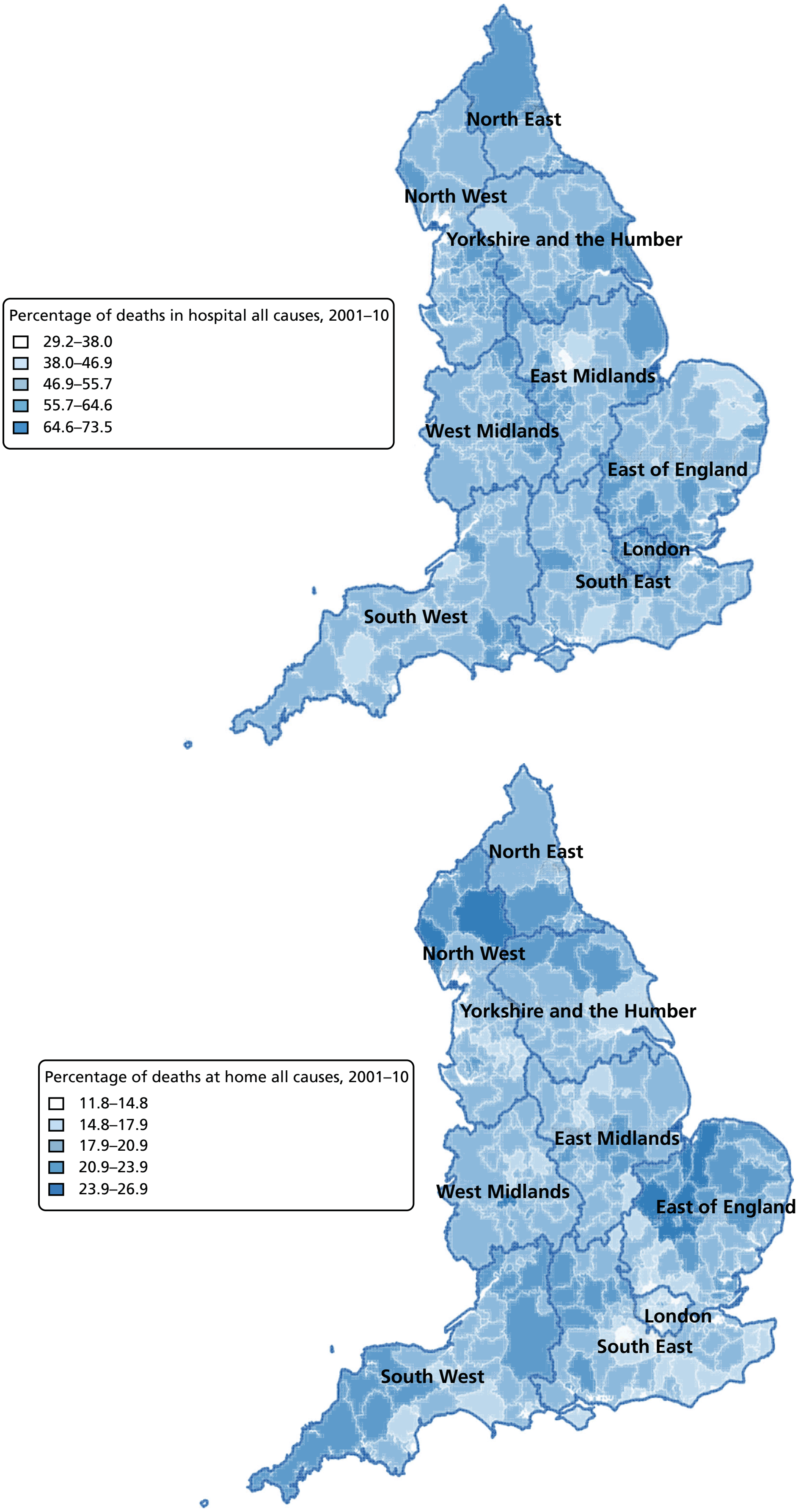

FIGURE 8 Percentage of hospital (a) vs. home deaths (b) for all causes combined by geographical areas, England 2001–10.

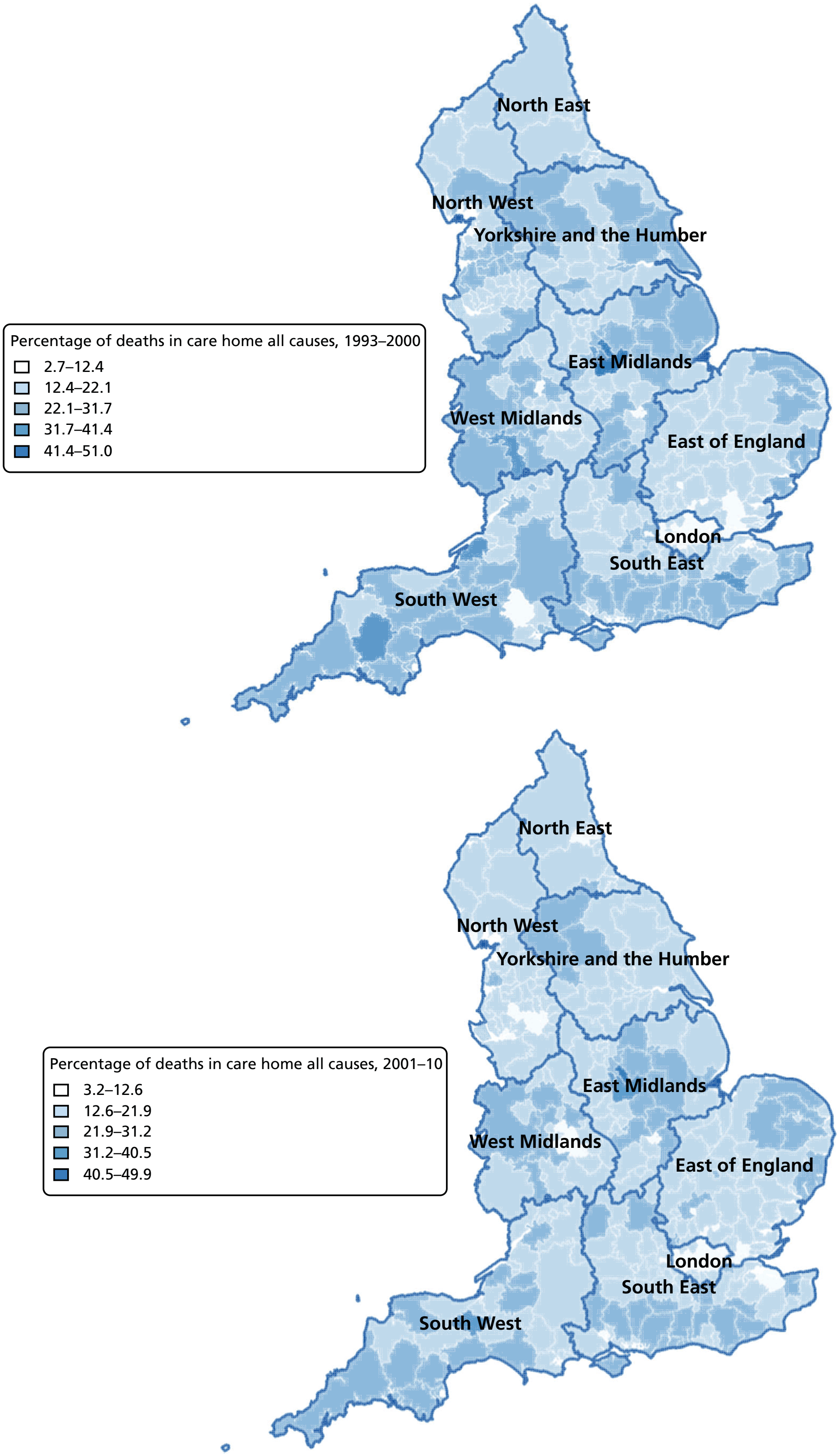

FIGURE 9 Percentage of care home deaths for all causes, combined by geographical areas, England (a) 1993–2000; and (b) 2001–10.

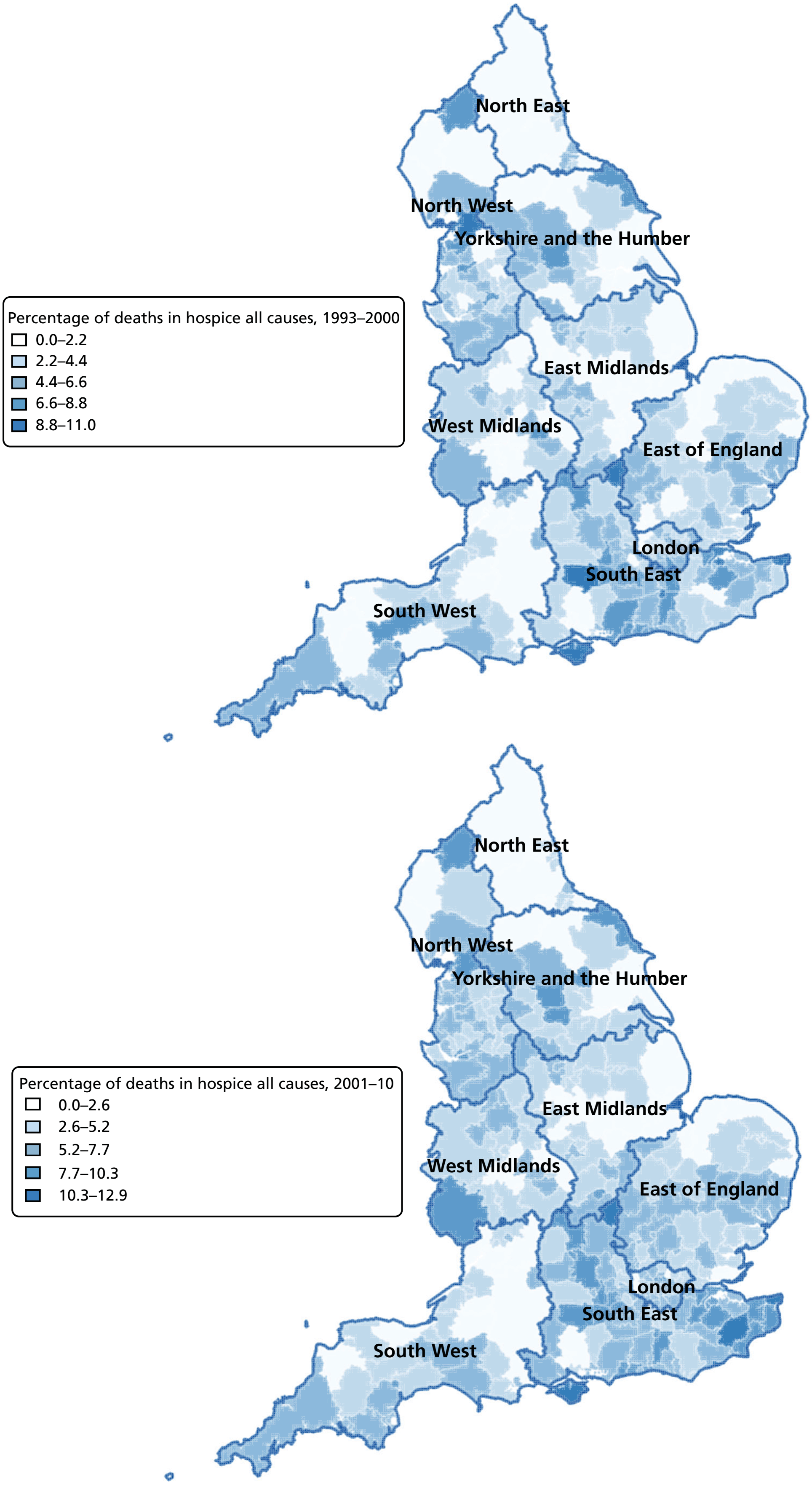

FIGURE 10 Percentage of hospice deaths for all causes, combined by geographical areas, England (a) 1993–2000; and (b) 2001–10.

Area-level regression analysis

Regional-level models on the basis of selected demographic and clinical variables together with a temporal variable (see *Table 10*) explained a statistically significant ($p < 0.001$) proportion of the variation in hospital deaths, ranging from 24.3% to 26.7% in the data with all causes combined. The models constructed at the PCO level tended to perform slightly better than those at the LA level; models incorporating holiday periods marginally outperformed those including the seasonal temporal variable. For every year increase in age, there was a 1.686% (95% CI 1.814% to 1.559%) to 1.613% (95% CI 1.829% to 1.397%) reduction in hospital deaths; every 1% increase in male proportion was associated with a 0.013% (95% CI 0.007% to 0.018%) to 0.005% (95% CI 0.000% to 0.010%) increase in deaths in hospitals; married marital status was negatively related to hospital deaths (–0.009%, 95% CI –0.012% to –0.006% for the PCO-level models; –0.012%, 95% CI –0.015% to –0.009% for the LA-level models). Year of death was positively related to proportion of hospital deaths, the more recent years' deaths were more likely to occur in hospitals: every year was associated with 0.277–0.279% increase in hospital deaths for the PCO models with holiday and seasonal variables, respectively. The corresponding figures for the LA-level models were 0.332% (95% CI 0.300% to 0.364%) and 0.339% (95% CI 0.307% to 0.371%).

A higher level of area deprivation was related to a higher proportion of hospital death at the PCO level. Every increasingly deprived IMD quintile was associated with a 0.415% (95% CI –0.043% to 0.874%) and 0.419% (95% CI –0.039% to 0.878%) increase in hospital deaths for the models with percentage winter deaths and percentage Christmas deaths. For the LA-level models, every increasingly deprived IMD quintile was associated with a 0.041% (95% CI –0.285% to 0.203%) reduction in proportion of hospital deaths in the seasonal model but an increase of 0.037% (95% CI –0.206% to 0.280%) in the holiday period model, although none of those was statistically significant. People who died in the winter had slightly lower but statistically non-significant chance of dying in hospital (–0.001%, 95% CI –0.006% to 0.004% for PCO-level model; –0.002%, 95% CI –0.008% to 0.003% for LA-level model); the Christmas period tended to be associated with an increased chance of people dying in hospital, with the –0.007% (95% CI –0.020% to 0.007%) of associated hospital deaths in the PCO-level model and –0.012% (95% CI –0.015% to –0.009%) in the LA model; the latter was statistically significant ($p < 0.001$).

The disease-specific models varied widely between diseases (*Tables 10* and *11*). The selected variables explained the least proportion of variation in the area-level models for cancer (5.4–6.9%), and the highest proportion for CBDs (38.2–39.0%) for PCO-level models and in non-cancer (36.5–37.2%) for LA-level models. The explained variation in hospital deaths by selected explanatory variables in CVDs, neurological conditions and COPD CoD accounted for between 6.6% and 26.1% of the observed variation. Overall, the holiday models performed equally well or slightly better than seasonal period models, the exception being in cancer deaths, for which seasonal models were slightly better, although the difference was minimal (6.9% vs. 6.8% for the PCO-level models and 5.5% vs. 5.4% for the LA models). The direction of travel for the individual explanatory variables in disease-specific models was consistent with that in all causes combined models for most disease groups, although the magnitude differed.

Age was consistently associated with lower hospital deaths in disease-specific models; this remained the case for PCO- and LA-level models: a 1-year increase in age was linked with a 0.204–2.650% reduction in hospital deaths; the link was strongest in CBDs. However, COPD deaths had inconsistent age patterns for PCOs (0.012%, 95% CI –0.209% to 0.233% in the seasonal model; –0.073%, 95% CI –0.299% to 0.154% in the holiday model), although none of them were statistically significant and the associations were weak. At the LA level, age was consistently associated with lower hospital deaths in COPD (–0.402%, 95% CI –0.546% to –0.257% in the seasonal model; –0.305%, 95% CI –0.467% to –0.143% in the holiday temporal model).

Male gender was associated with lower hospital deaths for non-cancer, cancer, CBD and neurological condition CoDs (0.003–0.870, all significant at the level of $p < 0.001$), but not in deaths from COPD and CVDs, for which these deaths had a negative parameter estimate but only COPD's parameters were

TABLE 10 Linear regression modelling[a] of proportion of deaths in hospitals on selected explanatory variables and percentage of winter deaths or Christmas deaths (shaded) at the PCO level

	All		Non-cancer		Cancer		CVD		CBD		Neurological conditions		COPD	
Characteristics	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
n^b	2718		2718		2718		2718		2718		2711		2718	
Adjusted *R* square, %	26.7		38.0		6.9		26.1		38.2		22.6		11.8	
Mean age, years	–1.613	–1.829 to –1.397	–2.011	–2.218 to –1.804	–0.413	–0.731 to –0.095	–1.588	–1.780 to –1.396	–2.586	–2.833 to –2.340	–0.407	–0.590 to –0.225	0.012	–0.209 to 0.233
% male	0.005	0.000 to 0.010	0.004	–0.002 to 0.010	0.016	–0.003 to 0.035	–0.005	–0.016 to 0.006	0.004	–0.026 to 0.035	0.445	0.295 to 0.595	–0.054	–0.085 to –0.022
% married	–0.009	–0.012 to –0.006	–0.013	–0.017 to –0.009	–0.002	–0.013 to 0.010	–0.033	–0.040 to –0.025	0.055	0.026 to 0.084	0.262	0.114 to 0.409	0.023	–0.013 to 0.059
Year of death	0.279	0.231 to 0.328	0.527	0.475 to 0.578	–0.204	–0.273 to –0.134	0.405	0.350 to 0.460	0.462	0.391 to 0.534	0.644	0.540 to 0.749	0.315	0.255 to 0.375
Average IMD ranking	0.415	–0.043 to 0.874	1.175	0.718 to 1.632	–1.459	–2.066 to –0.851	1.280	0.862 to 1.698	–0.642	–1.185 to –0.099	–3.882	–4.617 to –3.147	–1.412	–1.861 to –0.964
% death in winter	–0.001	–0.006 to 0.004	–0.002	–0.007 to 0.003	0.015	–0.006 to 0.035	–0.011	–0.022 to 0.001	0.000	–0.028 to 0.029	–0.020	–0.170 to 0.131	0.023	–0.007 to 0.053
Adjusted *R* square, %	26.7		38.0		6.8		26.1		39.0		25.5		11.8	
Mean age, years	–1.617	–1.833 to –1.401	–2.019	–2.226 to –1.812	–0.413	–0.731 to –0.095	–1.598	–1.790 to –1.406	–2.650	–2.899 to –2.401	–0.522	–0.767 to –0.277	–0.073	–0.299 to 0.154

continued

TABLE 10 Linear regression modelling[a] of proportion of deaths in hospitals on selected explanatory variables and percentage of winter deaths or Christmas deaths (shaded) at the PCO level (*continued*)

	All		Non-cancer		Cancer		CVD		CBD		Neurological conditions		COPD	
Characteristics	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
% male	0.005	0.000 to 0.010	0.004	–0.002 to 0.010	0.016	–0.003 to 0.035	–0.006	–0.017 to 0.005	0.003	–0.027 to 0.034	0.360	0.202 to 0.517	–0.057	–0.088 to –0.025
% married	–0.009	–0.012 to –0.006	–0.013	–0.017 to –0.009	–0.002	–0.014 to 0.010	–0.033	–0.040 to –0.025	0.054	0.025 to 0.083	0.223	0.067 to 0.379	0.025	–0.011 to 0.061
Year of death	0.277	0.228 to 0.326	0.524	0.473 to 0.576	–0.202	–0.272 to –0.133	0.410	0.354 to 0.465	0.470	0.399 to 0.541	0.684	0.555 to 0.813	0.307	0.246 to 0.367
Average IMD ranking	0.419	–0.039 to 0.878	1.179	0.722 to 1.635	–1.457	–2.065 to –0.849	1.270	0.852 to 1.688	–0.540	–1.085 to 0.004	–3.136	–4.092 to –2.179	–1.307	–1.765 to –0.849
% deaths in Christmas period	–0.007	–0.020 to 0.007	–0.011	–0.026 to 0.004	0.009	–0.061 to 0.080	–0.012	–0.044 to 0.021	–0.038	–0.134 to 0.058	0.067	–0.519 to 0.653	0.025	–0.068 to 0.118

a All models were significant at the level of $p < 0.0001$.
b This is '*n*' for both models.

TABLE 11 Linear regression modelling[a] of proportion of deaths in hospitals on selected explanatory variables and percentage of winter deaths/Christmas deaths (shaded) at the LA level

	All		Non-cancer		Cancer		CVD		CBD		Neurological conditions		COPD	
Characteristics	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
n^b	5867		5867		5861		5864		5846		5676		5839	
Adjusted *R* square, %	24.3		36.5		5.5		21.3		31.4		14.6		6.6	
Mean age	−1.630	−1.757 to −1.503	−2.250	−2.378 to −2.121	−0.204	−0.382 to −0.027	−1.569	−1.690 to −1.447	−2.391	−2.541 to −2.241	−0.536	−0.656 to −0.416	−0.402	−0.546 to −0.257
% male	0.013	0.008 to 0.019	0.010	0.004 to 0.017	0.051	0.031 to 0.071	−0.019	−0.032 to −0.005	0.092	0.059 to 0.125	0.833	0.651 to 1.015	−0.057	−0.100 to −0.014
% married	−0.012	−0.015 to −0.009	−0.012	−0.016 to −0.008	−0.029	−0.041 to −0.017	−0.038	−0.047 to −0.029	0.089	0.055 to 0.122	0.301	0.119 to 0.483	0.026	−0.021 to 0.073
Year of death	0.332	0.300 to 0.364	0.672	0.637 to 0.707	−0.289	−0.338 to −0.240	0.586	0.545 to 0.626	0.455	0.404 to 0.505	0.553	0.472 to 0.635	0.377	0.327 to 0.427
Average IMD ranking	−0.041	−0.285 to 0.203	0.719	0.460 to 0.979	−0.965	−1.306 to −0.625	0.601	0.341 to 0.861	−1.490	−1.820 to −1.161	−4.386	−4.867 to −3.905	−1.088	−1.417 to −0.760
% death in winter	−0.002	−0.008 to 0.003	−0.004	−0.010 to 0.002	0.012	−0.012 to 0.035	−0.013	−0.027 to 0.000	−0.003	−0.037 to 0.030	0.033	−0.149 to 0.214	0.029	−0.015 to 0.072
Adjusted *R* square, %	25.0		37.2		5.4		23.0		32.9		20.0		7.2	
Mean age, years	−1.686	−1.814 to −1.559	−2.318	−2.448 to −2.188	−0.234	−0.414 to −0.054	−1.656	−1.779 to −1.534	−2.584	−2.744 to −2.423	−0.503	−0.712 to −0.295	−0.305	−0.467 to −0.143

continued

TABLE 11 Linear regression modelling[a] of proportion of deaths in hospitals on selected explanatory variables and percentage of winter deaths/Christmas deaths (shaded) at the LA level (*continued*)

	All		Non-cancer		Cancer		CVD		CBD		Neurological conditions		COPD	
Characteristics	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
% male	0.013	0.007 to 0.018	0.009	0.002 to 0.015	0.050	0.030 to 0.070	–0.023	–0.036 to –0.010	0.081	0.047 to 0.115	0.870	0.627 to 1.113	–0.061	–0.104 to –0.018
% married	–0.012	–0.015 to –0.009	–0.011	–0.016 to –0.007	–0.028	–0.040 to –0.016	–0.038	–0.047 to –0.029	0.081	0.048 to 0.115	0.238	–0.007 to 0.484	0.033	–0.015 to 0.080
Year of death	0.339	0.307 to 0.371	0.681	0.646 to 0.716	–0.282	–0.331 to –0.234	0.609	0.569 to 0.648	0.485	0.433 to 0.537	0.690	0.562 to 0.817	0.361	0.307 to 0.414
Average IMD ranking	0.037	–0.206 to 0.280	0.817	0.557 to 1.076	–0.923	–1.263 to –0.583	0.705	0.447 to 0.964	–1.229	–1.575 to –0.884	–4.570	–5.347 to –3.793	–1.351	–1.710 to –0.991
% deaths in Christmas period	–0.012	–0.029 to 0.004	–0.020	–0.039 to –0.001	–0.013	–0.091 to 0.065	–0.006	–0.047 to 0.035	–0.021	–0.137 to 0.094	–0.037	–1.076 to 1.002	–0.013	–0.148 to 0.122

a All models were significant at the level of $p < 0.0001$.
b This is '*n*' for both models.

statistically significant (–0.054%, 95% CI –0.085% to –0.022% for the seasonal model; –0.057%, 95% CI –0.088% to –0.025% for the holiday temporal model at the PCO level; and –0.057%, 95% CI –0.100% to –0.014% for the seasonal model; –0.061%, 95% CI –0.104% to –0.018% for the holiday temporal model at the LA level).

The proportion of married people who died from a non-cancer, cancer or CVD cause was associated with lower hospital deaths (–0.002% to –0.038%), whereas among deaths from CBDs, neurological conditions and COPD, marital status was linked with an increased proportion of hospital deaths (0.023–0.301%). Again, the link was strongest for deaths from neurological conditions (0.223–0.301%). Along with the year, the proportion of hospital deaths increased in all selected CoD (annual increase 0.361–0.690%), with the only exception being cancer deaths (annual decrease –0.282% to –0.202%). The hospital deaths in non-cancer and CVD causes were linked with increased area deprivation (0.601–1.280%); however, deaths in hospitals from cancer, CBD, neurological conditions and COPD were related to reduced area deprivation (–4.570% to –1.457%). The regional models showed most of the temporal trends were not significant, although the direction of effect varied by CoD. The only significant trend was that deaths over the Christmas period had a lower chance of taking place in hospital (–0.013%, 95% CI –0.017% to –0.009%) for the PCO-level model.

The visual inspection of overall fit of area-level models, influence of outliers, normality, homoscedasticity and linearity assumption showed a consistent misfit pattern with the *R*-squared statistics: models with a higher value on *R* squared (e.g. non-cancer, CBD vs. cancer and COPD) had a better visual fit. We carried out transformation of data in an attempt to improve less well-fitted models but no tangible improvement was observed. For the interests of simplicity and ease of interpretation, we presented raw data-based models only.

Factors associated with place of death: multivariable modelling

In this section, we report the multivariate adjusted association between factors and PoD. The measure of effect is expressed as the PR, a more conservative but more appropriate measure of association than OR when the outcome of interest is common (> 10%). It is useful to bear this in mind when interpreting these results, as the effect presented by PR tends to be smaller than that of OR. Bivariate and area-level modelling analyses indicate that the factors associated with PoD are very different by cause of death, therefore we ran the multivariable regression modelling analysis separately for all causes, non-cancer causes, cancer, CVDs, CBDs, neurological conditions and COPDs.

For all causes, home or care home death compared with hospital death

For all CoDs combined, the probability of a patient dying at home decreased with increasing age across the three time periods; however, the age gap showed a tendency towards narrowing (PRs range 0.863–1.016), compared with patients who died aged 25–54 years (*Table 12*). Patients aged 85+ years had the lowest chance of dying at home (PRs 0.863–0.946). Male gender was associated with an increased chance of death at home and this was more pronounced in the earlier period (PR 1.034, 95% CI 1.032 to 1.036) than in the more recent periods (PR 1.007, 95% CI 1.007 to 1.008 for 1993–2000; PR 1.009, 95% CI 1.008 to 1.009 for 2001–10). Divorced people were less likely to die in hospital (PR 0.998, 95% CI 0.997 to 0.999) in 1993–2000, but more likely to die in hospital in 2001–10 (PR 1.027, 95% CI 1.024 to 1.030). Compared with married people, individuals who were widowed or single were more likely to die in hospital (PRs 0.992–0.998). Over the study period, deaths in hospital became more likely [PR 1.001 (95% CI 1.000 to 1.002) in 2001–10 vs. PR 0.998 (95% CI 0.998 to 0.999) in 1993–2000]. Deprivation was associated with a higher chance of hospital death; this was more pronounced in 1984–92 than in 1993–2010 (PRs 1.000–1.010 vs. PRs 1.030–1.076 for less deprived compared with most deprived). Across all periods and compared with the North West region, people in London had the highest chance of dying in hospital (PRs 0.872–0.988), and people in the South West had the highest chance of a home death (PRs 1.010–1.062).

TABLE 12 Proportion ratios (95% CI) of factors associated with place of all causes of deaths, results from multivariable modelling[a] (home vs. hospital), England 1984–2010

Variable	Value	Time period		
		1984–92	1993–2000	2001–10
Age, years	25–54	1.000	1.000	1.000
	55–64	1.016 (1.012 to 1.020)	0.998 (0.997 to 0.999)	0.999 (0.998 to 1.000)
	65–74	0.958 (0.954 to 0.961)	0.984 (0.983 to 0.985)	0.982 (0.981 to 0.983)
	75–84	0.874 (0.871 to 0.877)	0.962 (0.961 to 0.963)	0.958 (0.958 to 0.959)
	85+	0.863 (0.859 to 0.867)	0.946 (0.945 to 0.947)	0.938 (0.937 to 0.939)
Gender	Female	1.000	1.000	1.000
	Male	1.034 (1.032 to 1.036)	1.007 (1.007 to 1.008)	1.009 (1.008 to 1.009)
Marital status	Married	NA	1.000	1.000
	Widowed	NA	0.993 (0.993 to 0.994)	0.993 (0.993 to 0.994)
	Single	NA	0.992 (0.991 to 0.994)	0.998 (0.997 to 0.999)
	Divorced	NA	0.998 (0.997 to 0.999)	1.001 (1.000 to 1.002)
	NS/unknown	NA	1.019 (1.016 to 1.021)	1.027 (1.024 to 1.030)
Year of death	–	1.001 (1.001 to 1.002)	0.998 (0.998 to 0.999)	1.001 (1.001 to 1.001)
IMD	Most deprived	1.000	1.000	1.000
	2	1.030 (1.025 to 1.035)	1.001 (1.000 to 1.002)	1.000 (0.999 to 1.001)
	3	1.049 (1.043 to 1.055)	1.005 (1.004 to 1.006)	1.004 (1.003 to 1.005)
	4	1.067 (1.061 to 1.073)	1.009 (1.008 to 1.010)	1.007 (1.006 to 1.008)
	5	1.076 (1.070 to 1.083)	1.010 (1.009 to 1.011)	1.008 (1.007 to 1.009)
Region	North West	1.000	1.000	1.000
	East England	0.975 (0.969 to 0.981)	1.002 (1.001 to 1.004)	1.005 (1.004 to 1.006)
	East Midlands	1.004 (0.997 to 1.010)	0.999 (0.998 to 1.001)	1.000 (0.999 to 1.001)
	London	0.872 (0.867 to 0.876)	0.984 (0.982 to 0.985)	0.988 (0.987 to 0.989)
	North East	1.016 (1.009 to 1.023)	1.000 (0.998 to 1.002)	1.000 (0.998 to 1.001)
	South Central	1.024 (1.017 to 1.031)	1.008 (1.007 to 1.010)	1.002 (1.000 to 1.003)
	South East Coast	1.027 (1.020 to 1.034)	1.001 (0.999 to 1.003)	1.000 (0.998 to 1.001)
	South West	1.062 (1.056 to 1.069)	1.014 (1.012 to 1.015)	1.010 (1.008 to 1.011)
	West Midlands	1.057 (1.051 to 1.063)	1.005 (1.004 to 1.006)	0.998 (0.997 to 0.999)
	Yorkshire and the Humber	1.001 (0.996 to 1.007)	1.002 (1.001 to 1.004)	1.001 (1.000 to 1.002)

NA, not available; NS, not specified.
a The *p*-values for individual variables were significant at the level of $p < 0.0001$. PR of > 1 indicates a higher chance of dying in home; PR of < 1 indicates a higher chance of dying in hospital.

Care home deaths were more likely among older people for all CoD combined in 1993–2010 (PRs 0.941–0.996) (*Table 13*). Compared with care home death, men were more likely to die in hospital than women were (PRs 1.008–1.010) in the whole period; those who were married had a higher chance of dying in hospital than those who were widowed, single, divorced or unknown marital status (PRs 0.984–0.992) in recent periods; in the periods of 1993–2000 and 2001–10, widowed people had the highest chance of a care home death (PR 0.980, 95% CI 0.979 to 0.981 in 1993–2000; PR 0.985,

TABLE 13 Proportion ratios (95% CI) of factors associated with place of all causes of deaths, results from multivariable modelling[a] (care home vs. hospital), England 1984–2010

		Time period		
Variable	Value	1984–92[b]	1993–2000	2001–10
Age, years	25–54	1.000	1.000	1.000
	55–64	0.987 (0.982 to 0.992)	0.996 (0.995 to 0.996)	0.994 (0.993 to 0.994)
	65–74	0.994 (0.990 to 0.999)	0.987 (0.986 to 0.988)	0.985 (0.984 to 0.985)
	75–84	1.116 (1.110 to 1.122)	0.968 (0.968 to 0.969)	0.970 (0.969 to 0.970)
	85+	1.386 (1.377 to 1.395)	0.941 (0.941 to 0.942)	0.948 (0.947 to 0.949)
Gender	Female	1.000	1.000	1.000
	Male	0.887 (0.885 to 0.889)	1.008 (1.008 to 1.009)	1.010 (1.010 to 1.010)
Marital status	Married	NA	1.000	1.000
	Widowed	NA	0.989 (0.988 to 0.989)	0.991 (0.990 to 0.991)
	Single	NA	0.980 (0.979 to 0.981)	0.985 (0.985 to 0.986)
	Divorced	NA	0.989 (0.989 to 0.990)	0.992 (0.992 to 0.993)
	NS/unknown	NA	0.984 (0.983 to 0.986)	0.988 (0.986 to 0.989)
Year of death	–	1.022 (1.021 to 1.023)	1.001 (1.001 to 1.001)	1.000 (0.999 to 1.000)
IMD	Most deprived	1.000	1.000	1.000
	2	1.049 (1.019 to 1.080)	0.997 (0.996 to 0.998)	0.997 (0.996 to 0.998)
	3	1.069 (1.034 to 1.105)	0.994 (0.993 to 0.995)	0.995 (0.995 to 0.996)
	4	1.079 (1.041 to 1.118)	0.992 (0.991 to 0.993)	0.994 (0.993 to 0.995)
	5	1.091 (1.051 to 1.133)	0.992 (0.991 to 0.993)	0.994 (0.993 to 0.995)
Region	North West	1.000	1.000	1.000
	East England	0.875 (0.844 to 0.906)	1.003 (1.002 to 1.005)	1.001 (1.000 to 1.002)
	East Midlands	0.987 (0.954 to 1.021)	1.000 (0.998 to 1.001)	0.998 (0.997 to 1.000)
	London	0.643 (0.623 to 0.665)	1.016 (1.015 to 1.017)	1.012 (1.011 to 1.013)
	North East	0.931 (0.889 to 0.973)	0.992 (0.990 to 0.994)	0.994 (0.993 to 0.996)
	South Central	0.963 (0.928 to 0.998)	1.006 (1.004 to 1.008)	1.001 (0.999 to 1.002)
	South East Coast	0.972 (0.939 to 1.006)	0.998 (0.996 to 1.000)	0.998 (0.997 to 1.000)
	South West	1.045 (1.013 to 1.078)	0.994 (0.992 to 0.995)	0.993 (0.992 to 0.994)
	West Midlands	0.938 (0.908 to 0.968)	0.999 (0.997 to 1.000)	0.998 (0.996 to 0.999)
	Yorkshire and the Humber	0.928 (0.898 to 0.959)	1.001 (1.000 to 1.003)	0.996 (0.994 to 0.997)

NA, not available; NS, not specified.
a The *p*-values for individual variables were significant at the level of $p < 0.0001$.
b Hospital vs. other communal establishments. PR of > 1 indicates higher chance of hospital death; PR of < 1 indicates higher chance of care home death.

95% CI 0.985 to 0.986 in 2001–10). The number of care home deaths fell slightly in the period 1984–2000 (PRs 1.001–1.022), but remained stable for the period of 2001–10 (PR 1.000, 95% CI 0.999 to 1.000). Care home deaths were less likely among the least deprived (PRs 0.992–0.997 compared with the most deprived). Care home deaths were less likely in London than in the North West (PRs 1.012–1.016) but the regional gap was reduced in 2001–10; the South West region had the highest chance of care home deaths (PRs 0.993–0.994). In the period of 1984–92, the distribution of the explanatory variables by PoD (hospital vs. care home) showed distinctive patterns compared with the later periods (1993–2010) due to the coding changes in PoD.

For non-cancer causes, home or care home death compared with hospital death

Factors associated with non-cancer deaths followed similar patterns to that of all CoDs; the profile was similar in 1993–2000 and 2001–10, and distinctive from the period 1984–92 (*Table 14*). The chance of death in hospital compared with home increased with increasing age (PRs 0.912–1.026 in 1984–92; 0.954–0.998 in 1993–2000; 0.943–0.999 in 2001–10 for descending order of age groups). Male gender, marital status other than 'married' and living in a less-deprived area were all associated with increased chance of home death, compared with their respective reference groups (PRs 1.001–1.062). Men who died of non-cancer causes were more likely to die at home than women (PRs 1.013–1.046). Married people who died of non-cancer causes had higher chance of death at home than people who were widowed, single or divorced (PRs 1.009–1.054). There was a reduced chance of home deaths in the earlier periods (1984–2000), but in 2001–10 the probability of hospital compared with home death remained rather stable over the period (PR close to 1). Greater area-level deprivation increased the chance of home death in non-cancer causes of death, PRs increased with the increasingly deprived IMD quintiles (1.026–1.062 in 1984–92; 1.000–1.005 in 1993–2000; 0.999–1.003 in 2001–10). London had the lowest chances of home death for non-cancer causes (PRs 0.894–0.994) throughout the three-study period.

As in the all-CoD combined analyses, the profile for the associated factors of hospital death compared with care home deaths showed a distinctive pattern in 1984–92, with reference to recent periods (*Table 15*). The hospital analysis compared with care home analysis exhibited divergent patterns, for example although increasing age was associated with increased chance of hospital death in 1993–2000 (PRs 0.943–0.996), it appeared to be the opposite in the period of 1984–92 (PRs 0.999–1.596). This was particularly true for regional variation, for which London had the highest chance of care home death in 1984–92 (PR 0.560, 95% CI 0.534 to 0.587), the corresponding figures for 1993–2010 showed the highest chance of hospital death (PRs 1.013–1.015). Increased age, unmarried marital status and less area deprivation were all associated with an increased chance of a care home death (PRs 0.943–0.997) in 1993–2010, whereas in the period of 1984–92, increased age and less area deprivation were related to increased chance of hospital death (PRs 1.053–1.596) for the period of 1984–92.

For cancer causes, home or care home death compared with hospital death

Compared with those aged 25–54 years, people who died from cancer aged ≥ 65 years were more likely to die in hospital compared with home for all three periods (PRs 0.807–0.992), with the chance of dying at home (*Table 16*) decreasing with increasing age. For those in the 55- to 64-year age group, there was a higher chance of home death than for those aged 25–54 years (PRs 1.002–1.016); however, for the period 2001–10, the risk of hospital death was higher than for their younger peers (PR 0.999, 95% CI 0.998 to 1.001). Male gender, 'unmarried' marital status, and residing in regions other than the North West were all linked with hospital death with reference to home death (PRs 0.996–0.999), with the only exceptions being in the South West in 1993–2000 (PR 1.000, 95% CI 0.998 to 1.002) and the West Midlands in 1984–2000 (PR 1.013, 95% CI 1.006 to 1.021 in 1984–92; PR 1.005, 95% CI 1.004 to 1.007 in 1993–2000). Less area deprivation was consistently associated with an increased chance of home death (PRs 1.002–1.105). In 1984–92, male gender was related to increased probability of a home death (PR 1.016, 95% CI 1.014 to 1.019).

TABLE 14 Proportion ratios (95% CI) of factors associated with place of non-cancer cause of deaths, derived from multivariable modelling[a] (home vs. hospital), England 1984–2010

Variable	Value	Time period		
		1984–92	1993–2000	2001–10
Age, years	25–54	1.000	1.000	1.000
	55–64	1.026 (1.020 to 1.031)	0.998 (0.996 to 0.999)	0.999 (0.998 to 1.000)
	65–74	0.980 (0.975 to 0.985)	0.988 (0.987 to 0.989)	0.980 (0.979 to 0.981)
	75–84	0.910 (0.905 to 0.914)	0.968 (0.967 to 0.969)	0.960 (0.959 to 0.961)
	85+	0.912 (0.907 to 0.917)	0.954 (0.952 to 0.955)	0.943 (0.942 to 0.944)
Gender	Female	1.000	1.000	1.000
	Male	1.046 (1.043 to 1.048)	1.013 (1.012 to 1.013)	1.015 (1.014 to 1.015)
Marital status	Married	NA	1.000	1.000
	Widowed	NA	1.009 (1.008 to 1.010)	1.011 (1.010 to 1.012)
	Single	NA	1.016 (1.014 to 1.017)	1.026 (1.025 to 1.027)
	Divorced	NA	1.021 (1.019 to 1.022)	1.026 (1.025 to 1.027)
	NS/unknown	NA	1.038 (1.035 to 1.041)	1.054 (1.051 to 1.056)
Year of death	–	0.997 (0.997 to 0.998)	0.998 (0.998 to 0.998)	1.000 (1.000 to 1.000)
IMD	Most deprived	1.000	1.000	1.000
	2	1.026 (1.020 to 1.032)	1.000 (0.999 to 1.001)	0.999 (0.998 to 1.000)
	3	1.045 (1.038 to 1.051)	1.003 (1.001 to 1.004)	1.001 (1.000 to 1.002)
	4	1.060 (1.053 to 1.067)	1.005 (1.004 to 1.006)	1.003 (1.002 to 1.004)
	5	1.062 (1.055 to 1.069)	1.005 (1.003 to 1.006)	1.002 (1.001 to 1.003)
Region	North West	1.000	1.000	1.000
	East England	1.009 (1.002 to 1.017)	1.004 (1.002 to 1.006)	1.007 (1.006 to 1.009)
	East Midlands	1.046 (1.038 to 1.054)	1.004 (1.002 to 1.006)	1.003 (1.001 to 1.004)
	London	0.894 (0.888 to 0.899)	0.987 (0.986 to 0.989)	0.994 (0.993 to 0.995)
	North East	1.049 (1.041 to 1.058)	1.001 (0.998 to 1.003)	0.999 (0.997 to 1.001)
	South Central	1.064 (1.055 to 1.073)	1.013 (1.011 to 1.015)	1.006 (1.004 to 1.007)
	South East Coast	1.054 (1.046 to 1.062)	1.003 (1.001 to 1.005)	1.003 (1.002 to 1.005)
	South West	1.105 (1.097 to 1.112)	1.017 (1.016 to 1.019)	1.013 (1.011 to 1.014)
	West Midlands	1.078 (1.071 to 1.085)	1.004 (1.003 to 1.006)	1.000 (0.999 to 1.001)
	Yorkshire and the Humber	1.009 (1.003 to 1.016)	1.005 (1.004 to 1.007)	1.005 (1.003 to 1.006)

NA, not available; NS, not specified.

a The *p*-values for individual variables were significant at the level of $p < 0.05$. PR of > 1 indicates higher chance of dying in home; PR of < 1 indicates higher chance of dying in hospital.

TABLE 15 Proportion ratios (95% CI) of factors associated with place of non-cancer cause of deaths, results from multivariable modelling[a] (care home vs. hospital), England 1984–2010

Variable	Value	Time period		
		1984–92[a]	1993–2000	2001–10
Age (years)	25–54	1.000	1.000	1.000
	55–64	0.999 (0.993 to 1.005)	0.996 (0.996 to 0.997)	0.996 (0.995 to 0.996)
	65–74	1.058 (1.052 to 1.064)	0.988 (0.987 to 0.988)	0.987 (0.986 to 0.987)
	75–84	1.259 (1.251 to 1.268)	0.969 (0.968 to 0.970)	0.972 (0.972 to 0.973)
	85+	1.596 (1.584 to 1.608)	0.943 (0.942 to 0.944)	0.950 (0.950 to 0.951)
Gender	Female	1.000	1.000	1.000
	Male	0.889 (0.886 to 0.892)	1.009 (1.009 to 1.009)	1.012 (1.011 to 1.012)
Marital status	Married	NA	1.000	1.000
	Widowed	NA	0.991 (0.991 to 0.992)	0.994 (0.994 to 0.995)
	Single	NA	0.982 (0.982 to 0.983)	0.989 (0.989 to 0.990)
	Divorced	NA	0.992 (0.991 to 0.993)	0.997 (0.996 to 0.998)
	NS/unknown	NA	0.986 (0.985 to 0.988)	0.994 (0.992 to 0.996)
Year of death	–	1.018 (1.017 to 1.019)	1.001 (1.001 to 1.001)	1.000 (1.000 to 1.000)
IMD region	Most deprived	1.000	1.000	1.000
	2	1.053 (1.015 to 1.091)	0.996 (0.995 to 0.997)	0.996 (0.995 to 0.997)
	3	1.074 (1.031 to 1.120)	0.993 (0.991 to 0.994)	0.994 (0.993 to 0.995)
	4	1.086 (1.040 to 1.135)	0.990 (0.989 to 0.992)	0.991 (0.990 to 0.993)
	5	1.099 (1.050 to 1.151)	0.989 (0.988 to 0.991)	0.991 (0.990 to 0.993)
	North West	1.000	1.000	1.000
	East England	0.825 (0.786 to 0.865)	1.003 (1.001 to 1.005)	1.002 (1.001 to 1.003)
	East Midlands	0.965 (0.923 to 1.008)	0.998 (0.996 to 1.000)	0.998 (0.996 to 0.999)
	London	0.560 (0.534 to 0.587)	1.015 (1.014 to 1.016)	1.013 (1.011 to 1.014)
	North East	0.890 (0.837 to 0.948)	0.991 (0.988 to 0.993)	0.995 (0.993 to 0.996)
	South Central	0.920 (0.877 to 0.965)	1.005 (1.003 to 1.007)	0.998 (0.997 to 1.000)
	South East Coast	0.990 (0.946 to 1.036)	0.996 (0.994 to 0.998)	0.998 (0.996 to 0.999)
	South West	1.038 (0.996 to 1.081)	0.990 (0.989 to 0.992)	0.991 (0.990 to 0.993)
	West Midlands	0.924 (0.885 to 0.965)	0.999 (0.997 to 1.000)	0.998 (0.997 to 0.999)
	Yorkshire and the Humber	0.918 (0.879 to 0.959)	1.000 (0.999 to 1.002)	0.997 (0.996 to 0.999)

NA, not available; NS, not specified.
a The p-values for individual variables were significant at the level of $p < 0.05$.
b Hospital vs. other communal establishments. PR of > 1 indicates higher chance of hospital death; PR of < 1 indicates higher chance of care home death.

TABLE 16 Proportion ratios (95% CI) of factors associated with place of cancer cause of deaths, derived from multivariable modelling[a] (home vs. hospital), England 1984–2010

Variable	Value	Time period 1984–92	1993–2000	2001–10
Age, years	25–54	1.000	1.000	1.000
	55–64	1.016 (1.011 to 1.022)	1.002 (1.000 to 1.003)	0.999 (0.998 to 1.001)
	65–74	0.956 (0.951 to 0.961)	0.992 (0.991 to 0.994)	0.991 (0.990 to 0.993)
	75–84	0.861 (0.856 to 0.865)	0.974 (0.972 to 0.975)	0.978 (0.976 to 0.979)
	85+	0.807 (0.802 to 0.813)	0.959 (0.957 to 0.961)	0.962 (0.960 to 0.964)
Gender	Female	1.000	1.000	1.000
	Male	1.016 (1.014 to 1.019)	0.996 (0.995 to 0.996)	0.995 (0.994 to 0.996)
Marital status	Married	NA	1.000	1.000
	Widowed	NA	0.958 (0.957 to 0.959)	0.961 (0.960 to 0.961)
	Single	NA	0.935 (0.934 to 0.937)	0.937 (0.936 to 0.938)
	Divorced	NA	0.953 (0.952 to 0.955)	0.956 (0.955 to 0.958)
	NS/unknown	NA	0.971 (0.966 to 0.976)	0.959 (0.954 to 0.964)
Year of death	–	1.010 (1.010 to 1.011)	0.999 (0.999 to 0.999)	1.003 (1.003 to 1.004)
IMD	Most deprived	1.000	1.000	1.000
	2	1.036 (1.030 to 1.041)	1.002 (1.001 to 1.004)	1.002 (1.001 to 1.003)
	3	1.057 (1.050 to 1.063)	1.008 (1.007 to 1.010)	1.007 (1.005 to 1.008)
	4	1.082 (1.075 to 1.089)	1.015 (1.014 to 1.017)	1.013 (1.012 to 1.015)
	5	1.105 (1.098 to 1.112)	1.020 (1.018 to 1.021)	1.017 (1.015 to 1.018)
Region	North West	1.000	1.000	1.000
	East England	0.902 (0.895 to 0.910)	0.995 (0.993 to 0.997)	0.997 (0.995 to 0.999)
	East Midlands	0.914 (0.906 to 0.922)	0.984 (0.982 to 0.986)	0.990 (0.988 to 0.992)
	London	0.828 (0.822 to 0.834)	0.973 (0.971 to 0.974)	0.972 (0.970 to 0.974)
	North East	0.946 (0.937 to 0.955)	0.996 (0.993 to 0.998)	0.997 (0.994 to 0.999)
	South Central	0.939 (0.931 to 0.948)	0.996 (0.994 to 0.999)	0.991 (0.989 to 0.993)
	South East Coast	0.970 (0.961 to 0.978)	0.994 (0.992 to 0.996)	0.992 (0.990 to 0.994)
	South West	0.973 (0.964 to 0.981)	1.000 (0.998 to 1.002)	0.999 (0.998 to 1.001)
	West Midlands	1.013 (1.006 to 1.021)	1.005 (1.004 to 1.007)	0.992 (0.990 to 0.994)
	Yorkshire and the Humber	0.983 (0.975 to 0.990)	0.993 (0.991 to 0.995)	0.992 (0.990 to 0.994)

NA, not available; NS, not specified.
a The *p*-values for individual variables were significant at the level of $p < 0.0001$. PR of > 1 indicates higher chance of dying in home; PR of < 1 indicates higher chance of dying in hospital.

For the period of 1993–2000, care home deaths for those dying of cancer were increasingly more likely with increasing age (PRs 0.940–0.995), unmarried marital status (PRs 0.973–0.982), male gender (PR 1.006, 95% CI 1.005 to 1.007) and less area deprivation (PRs 0.993–0.998) (*Table 17*). Over the study period, the most likely PoD for cancer changed from hospital (PR 1.032, 95% CI 1.031 to 1.032) in 1984–92 to care home (PR 0.998, 95% CI 0.998 to 0.998) in 2001–10. The overall risk pattern of hospital

TABLE 17 Proportion ratios (95% CI) of factors associated with place of cancer cause of deaths, results from multivariable modelling[a] (care home vs. hospital), England 1984–2010

		Time period		
Variable	Value	1984–92[b]	1993–2000	2001–10
Age, years	25–54	1.000	1.000	1.000
	55–64	0.999 (0.992 to 1.005)	0.995 (0.994 to 0.996)	0.993 (0.992 to 0.993)
	65–74	1.004 (0.998 to 1.010)	0.988 (0.987 to 0.988)	0.983 (0.982 to 0.984)
	75–84	1.063 (1.056 to 1.070)	0.971 (0.970 to 0.971)	0.966 (0.965 to 0.967)
	85+	1.212 (1.202 to 1.222)	0.943 (0.942 to 0.944)	0.940 (0.939 to 0.941)
Gender	Female	1.000	1.000	1.000
	Male	0.903 (0.900 to 0.906)	1.006 (1.005 to 1.007)	1.006 (1.006 to 1.007)
Marital status	Married	NA	1.000	1.000
	Widowed	NA	0.981 (0.980 to 0.982)	0.979 (0.978 to 0.980)
	Single	NA	0.973 (0.971 to 0.974)	0.973 (0.972 to 0.974)
	Divorced	NA	0.982 (0.981 to 0.983)	0.980 (0.980 to 0.981)
	NS/unknown	NA	0.977 (0.974 to 0.981)	0.981 (0.978 to 0.984)
Year of death	–	1.032 (1.031 to 1.032)	1.000 (1.000 to 1.000)	0.998 (0.998 to 0.998)
IMD	Most deprived	1.000	1.000	1.000
	2	1.042 (1.032 to 1.052)	0.996 (0.995 to 0.998)	0.998 (0.997 to 0.999)
	3	1.054 (1.043 to 1.065)	0.995 (0.994 to 0.996)	0.997 (0.996 to 0.999)
	4	1.080 (1.068 to 1.092)	0.993 (0.992 to 0.994)	0.996 (0.995 to 0.997)
	5	1.103 (1.091 to 1.115)	0.994 (0.992 to 0.995)	0.996 (0.995 to 0.997)
Region	North West	1.000	1.000	1.000
	East England	0.813 (0.802 to 0.823)	1.007 (1.005 to 1.009)	1.001 (0.999 to 1.003)
	East Midlands	0.804 (0.792 to 0.815)	1.004 (1.002 to 1.006)	0.999 (0.998 to 1.001)
	London	0.896 (0.886 to 0.905)	1.024 (1.022 to 1.025)	1.014 (1.013 to 1.016)
	North East	0.774 (0.761 to 0.787)	0.995 (0.993 to 0.998)	0.994 (0.992 to 0.997)
	South Central	0.911 (0.897 to 0.926)	1.012 (1.010 to 1.014)	1.007 (1.006 to 1.009)
	South East Coast	1.059 (1.044 to 1.074)	1.002 (0.999 to 1.004)	1.000 (0.998 to 1.002)
	South West	0.965 (0.952 to 0.979)	1.001 (0.999 to 1.002)	0.997 (0.995 to 0.999)
	West Midlands	0.963 (0.951 to 0.974)	1.000 (0.998 to 1.002)	0.997 (0.995 to 0.999)
	Yorkshire and the Humber	0.971 (0.959 to 0.983)	1.005 (1.003 to 1.007)	0.993 (0.991 to 0.995)

NA, not available; NS, not specified.
a The *p*-values for individual variables were significant at the level of $p < 0.0001$.
b Hospital vs. other communal establishments. PR of > 1 indicates higher chance of hospital death; PR of < 1 indicates higher chance of care home death.

compared with care home for cancer deaths showed that dying in hospital was more likely among older ages (PRs 1.004–1.212), and for those from less-deprived areas (PRs 1.042–1.103) in 1984–92. Men were more likely to die in care homes than women in the early period (PR 0.903, 95% CI 0.900 to 0.906). The regional variations in hospital compared with care home death showed mixed patterns, with the majority of regions (seven out of nine in 1993–2000, four out of nine in 2001–10) having higher hospital deaths than the North West region, although in 1984–92, the only region with hospital deaths higher than the North West region was the South East Coast region (PR 1.059, 95% CI 1.044 to 1.074).

The inequality in the hospital deaths compared with care home deaths tended to reduce over time; it was evident for almost all explanatory variables of interest, and more pronounced for level of area deprivation. Compared with the most deprived quintile, the lowest PR was 0.993 (95% CI 0.992 to 0.994) in 1993–2000; the lowest PR became 0.996 (95% CI 0.995 to 0.997) in 2001–10.

For cardiovascular and cerebrovascular diseases, home or care home death compared with hospital death

Compared with the other CoD, the risk profile for PoD was more homogeneous in the three periods for patients who died from CVDs (*Table 18*). The chance of hospital death for people who died from CVDs increased with increasing age in three time periods; PRs in ascending order of age groups compared with 25–54 years changed from a higher chance of home death (1.020, 95% CI 1.012 to 1.027 in 1984–92; 1.004, 95% CI 1.002 to 1.004 in 1993–2000; 1.010, 95% CI 1.008 to 1.012 in 2001–10) for 55–64 years to a higher chance of hospital death (0.931, 95% CI 0.925 to 0.938 in 1984–92; 0.962, 95% CI 0.960 to 0.963 in 1993–2000; 0.947, 95% CI 0.945 to 0.948 in 2001–10) for groups of 85+ years. There was an increased chance of home death for males but the chance of home death decreased from the earlier to later periods [PR 1.032 (95% CI 1.029 to 1.035) in 1984–92 to PR 1.017 (95% CI 1.016 to 1.018) in 2001–10]. Compared with married people who died from a CVD cause, people with 'other marital status' had an increased chance of home death (PRs 1.014–1.065); divorced people in the period 1993–2010 had the highest probability of a home death (PR 1.043, 95% CI 1.039 to 1.047 in 1993–2000; PR 1.065, 95% CI 1.060 to 1.069 in 2001–10).

The likelihood of a patient dying in hospital decreased over time; the PRs of hospital deaths changed from 0.992 (95% CI 0.992 to 0.993) in 1984–92 to 0.998 (95% CI 0.998 to 0.998) in 1993–2000, to a higher chance of a home death, 1.001 (95% CI 1.001 to 1.001) in 2001–10. People were increasingly more likely to die in hospital with increased area deprivation, although the gap between IMD quintiles decreased (PRs 1.024–1.049 in 1984–92; PRs 1.000–1.007 in 1993–2000; PRs 0.999–1.004 in 2001–10). London had the highest chance of hospital death for patients who died from a CVD cause (PRs of 0.893, 0.986 and 0.993 for 1984–92, 1993–2000 and 2001–10, respectively).

Care home deaths in people who died from CVD causes compared with hospital death increased with increasing age in 1993–2010 PRs 0.955 (95% CI 0.954 to 0.956) for 85+ years to 1.000 (95% CI 0.999 to 1.001) for 55–64 years in 1993–2000; PRs 0.961 (95% CI 0.960 to 0.962) for 85+ years to 0.996 (95% CI 0.996 to 0.997) for 55–64 years in 2001–10] (*Table 19*). Men had a higher chance of care home death in the earlier period (PR 0.879, 95% CI 0.875 to 0.882), whereas in the later period men had a higher chance of hospital deaths (PRs 1.009–1.010). 'Unmarried' marital status (PRs 0.982–0.989) and higher level of area deprivation (PRs 0.991–0.997) were associated with higher chance of hospital death from CVD for the period 1993–2010. North and East Midlands and North East regions had a consistently higher chance of care home death than the North West region.

TABLE 18 Proportion ratios (95% CI) of factors associated with place of CVD cause of deaths, derived from multivariable modelling[a] (home vs. hospital), England 1984–2010

Variable	Value	Time period		
		1984–92	1993–2000	2001–10
Age, years	25–54	1.000	1.000	1.000
	55–64	1.020 (1.012 to 1.027)	1.004 (1.002 to 1.006)	1.010 (1.008 to 1.012)
	65–74	1.001 (0.995 to 1.008)	0.999 (0.997 to 1.001)	0.995 (0.993 to 0.997)
	75–84	0.955 (0.949 to 0.961)	0.983 (0.981 to 0.985)	0.975 (0.974 to 0.977)
	85+	0.931 (0.925 to 0.938)	0.962 (0.960 to 0.963)	0.947 (0.945 to 0.948)
Gender	Female	1.000	1.000	1.000
	Male	1.032 (1.029 to 1.035)	1.014 (1.013 to 1.014)	1.017 (1.016 to 1.018)
Marital status	Married	NA	1.000	1.000
	Widowed	NA	1.014 (1.013 to 1.015)	1.020 (1.020 to 1.021)
	Single	NA	1.028 (1.026 to 1.029)	1.044 (1.042 to 1.045)
	Divorced	NA	1.031 (1.029 to 1.032)	1.042 (1.040 to 1.043)
	NS/unknown	NA	1.043 (1.039 to 1.047)	1.065 (1.060 to 1.069)
Year of death	–	0.992 (0.992 to 0.993)	0.998 (0.998 to 0.998)	1.001 (1.001 to 1.001)
IMD	Most deprived	1.000	1.000	1.000
	2	1.024 (1.019 to 1.029)	1.000 (0.999 to 1.001)	0.999 (0.998 to 1.001)
	3	1.041 (1.036 to 1.047)	1.004 (1.003 to 1.006)	1.002 (1.001 to 1.004)
	4	1.048 (1.042 to 1.054)	1.007 (1.006 to 1.009)	1.004 (1.003 to 1.006)
	5	1.049 (1.043 to 1.055)	1.005 (1.004 to 1.007)	1.002 (1.001 to 1.004)
Region	North West	1.000	1.000	1.000
	East England	1.039 (1.031 to 1.047)	1.010 (1.008 to 1.012)	1.011 (1.009 to 1.013)
	East Midlands	1.075 (1.066 to 1.083)	1.010 (1.008 to 1.012)	1.004 (1.002 to 1.006)
	London	0.893 (0.887 to 0.899)	0.986 (0.984 to 0.987)	0.993 (0.991 to 0.994)
	North East	1.077 (1.068 to 1.086)	1.007 (1.005 to 1.010)	1.006 (1.004 to 1.008)
	South Central	1.091 (1.082 to 1.100)	1.019 (1.017 to 1.021)	1.009 (1.007 to 1.011)
	South East Coast	1.064 (1.056 to 1.072)	1.005 (1.003 to 1.007)	1.006 (1.004 to 1.008)
	South West	1.127 (1.119 to 1.134)	1.025 (1.023 to 1.027)	1.017 (1.015 to 1.019)
	West Midlands	1.104 (1.096 to 1.111)	1.006 (1.004 to 1.008)	1.004 (1.002 to 1.005)
	Yorkshire and the Humber	1.020 (1.013 to 1.027)	1.007 (1.005 to 1.008)	1.006 (1.005 to 1.008)

NA, not available; NS, not specified.
a The *p*-values for individual variables were significant at the level of $p < 0.0001$. PR of > 1 indicates higher chance of dying in home; PR of < 1 indicates higher chance of dying in hospital.

TABLE 19 Proportion ratios (95% CI) of factors associated with place of CVD cause of deaths, results from multivariable modelling[a] (care home vs. hospital), England 1984–2010

		Time period		
Variable	Value	1984–92[b]	1993–2000	2001–10
Age, years	25–54	1.000	1.000	1.000
	55–64	0.999 (0.992 to 1.006)	1.000 (0.999 to 1.001)	0.996 (0.996 to 0.997)
	65–74	1.040 (1.032 to 1.047)	0.997 (0.996 to 0.998)	0.992 (0.992 to 0.993)
	75–84	1.253 (1.244 to 1.263)	0.984 (0.983 to 0.985)	0.983 (0.982 to 0.983)
	85+	1.691 (1.676 to 1.705)	0.955 (0.954 to 0.956)	0.961 (0.960 to 0.962)
Gender	Female	1.000	1.000	1.000
	Male	0.879 (0.875 to 0.882)	1.009 (1.008 to 1.009)	1.010 (1.009 to 1.010)
Marital status	Married	NA	1.000	1.000
	Widowed	NA	0.986 (0.986 to 0.987)	0.989 (0.989 to 0.990)
	Single	NA	0.978 (0.977 to 0.979)	0.982 (0.981 to 0.983)
	Divorced	NA	0.989 (0.988 to 0.990)	0.991 (0.990 to 0.992)
	NS/unknown	NA	0.984 (0.982 to 0.987)	0.983 (0.980 to 0.986)
Year of death	–	1.008 (1.007 to 1.009)	1.001 (1.001 to 1.001)	1.000 (1.000 to 1.000)[c]
IMD	Most deprived	1.000	1.000	1.000
	2	1.055 (1.025 to 1.085)	0.996 (0.995 to 0.997)	0.997 (0.996 to 0.998)
	3	1.084 (1.052 to 1.118)	0.993 (0.992 to 0.994)	0.995 (0.994 to 0.996)
	4	1.081 (1.048 to 1.115)	0.992 (0.990 to 0.993)	0.993 (0.992 to 0.994)
	5	1.096 (1.062 to 1.131)	0.991 (0.990 to 0.992)	0.994 (0.992 to 0.995)
Region	North West	1.000	1.000	1.000
	East England	0.892 (0.864 to 0.921)	1.006 (1.004 to 1.008)	1.002 (1.001 to 1.004)
	East Midlands	0.975 (0.944 to 1.006)	0.999 (0.997 to 1.000)	0.999 (0.997 to 1.000)
	London	0.719 (0.699 to 0.740)	1.015 (1.013 to 1.016)	1.009 (1.008 to 1.010)
	North East	0.925 (0.889 to 0.962)	0.993 (0.991 to 0.996)	0.995 (0.993 to 0.997)
	South Central	0.975 (0.943 to 1.008)	1.008 (1.006 to 1.010)	1.000 (0.998 to 1.002)
	South East Coast	1.045 (1.012 to 1.078)	0.995 (0.993 to 0.997)	0.995 (0.994 to 0.997)
	South West	1.043 (1.013 to 1.074)	0.993 (0.992 to 0.995)	0.994 (0.992 to 0.995)
	West Midlands	0.962 (0.934 to 0.991)	0.999 (0.997 to 1.000)	0.998 (0.996 to 0.999)
	Yorkshire and the Humber	0.932 (0.904 to 0.960)	1.003 (1.001 to 1.005)	0.999 (0.997 to 1.000)

NA, not available; NS, not specified.
a The p-values for individual variables were significant at the level of $p < 0.0001$.
b Hospital vs. other communal establishments. PR of > 1 indicates higher chance of hospital death; PR of < 1 indicates higher chance of care home death.
c The p-value = 0.64.

The risk profile for the factors associated with the CBD CoD followed that of people who died from CVD (*Tables 20* and *21*). The CBD deaths showed a tendency of increased probability of death in hospital compared with a home death, and a similar pattern can be seen for hospital compared with care home death modelling.

TABLE 20 Proportion ratios (95% CI) of factors associated with place of CBD cause of deaths, derived from multivariable modelling[a] (home vs. hospital), England 1984–2010

Variable	Value	Time period		
		1984–92	1993–2000	2001–10
Age, years	25–54	1.000	1.000	1.000
	55–64	1.028 (1.008–1.048)	0.990 (0.986 to 0.993)	0.994 (0.991 to 0.997)
	65–74	1.037 (1.019 to 1.056)	0.984 (0.981 to 0.987)	0.978 (0.975 to 0.981)
	75–84	1.087 (1.069 to 1.106)	0.977 (0.974 to 0.980)	0.971 (0.969 to 0.974)
	85+	1.229 (1.207 to 1.251)	0.981 (0.978 to 0.984)	0.970 (0.967 to 0.973)
Gender	Female	1.000	1.000	1.000
	Male	0.980 (0.974 to 0.985)	0.999 (0.998 to 1.000)	0.999 (0.998 to 1.000)
	Married	NA	1.000	1.000
	Widowed	NA	1.006 (1.005 to 1.008)	1.004 (1.003 to 1.005)
	Single	NA	1.009 (1.007 to 1.011)	1.010 (1.008 to 1.012)
	Divorced	NA	1.015 (1.012 to 1.018)	1.013 (1.011 to 1.015)
	NS/unknown	NA	1.016 (1.010 to 1.023)	1.020 (1.013 to 1.027)
Year of death	–	1.003 (1.002 to 1.004)	0.999 (0.998 to 0.999)	1.000 (1.000 to 1.000)
IMD	Most deprived	1.000	1.000	1.000
	2	1.051 (1.039 to 1.063)	1.001 (0.999 to 1.003)	1.001 (0.999 to 1.003)
	3	1.083 (1.070 to 1.097)	1.006 (1.004 to 1.008)	1.004 (1.003 to 1.006)
	4	1.131 (1.116 to 1.145)	1.009 (1.007 to 1.011)	1.007 (1.005 to 1.009)
	5	1.142 (1.126 to 1.157)	1.011 (1.009 to 1.013)	1.009 (1.006 to 1.011)
Region	North West	1.000	1.000	1.000
	East England	0.933 (0.919 to 0.947)	0.998 (0.995 to 1.000)	1.002 (0.999 to 1.004)
	East Midlands	0.982 (0.966 to 0.998)	1.000 (0.997 to 1.002)	1.001 (0.999 to 1.004)
	London	0.852 (0.841 to 0.864)	0.992 (0.990 to 0.994)	0.995 (0.993 to 0.997)
	North East	0.981 (0.964 to 0.998)	0.992 (0.988 to 0.996)	0.993 (0.990 to 0.997)
	South Central	0.984 (0.966 to 1.001)	1.003 (1.000 to 1.006)	0.998 (0.995 to 1.001)
	South East Coast	1.008 (0.991 to 1.024)	1.000 (0.997 to 1.003)	1.002 (0.999 to 1.004)
	South West	1.041 (1.026 to 1.057)	1.003 (1.001 to 1.006)	1.004 (1.001 to 1.006)
	West Midlands	1.016 (1.001 to 1.030)	1.000 (0.998 to 1.003)	0.996 (0.994 to 0.998)
	Yorkshire and the Humber	0.973 (0.959 to 0.987)	1.001 (0.999 to 1.004)	1.000 (0.998 to 1.002)

NA, not available; NS, not specified.
a The *p*-values for individual variables were significant at the level of $p < 0.0001$. PR of > 1 indicates higher chance of dying in home; PR of < 1 indicates higher chance of dying in hospital.

TABLE 21 Proportion ratios (95% CI) of factors associated with place of CBD cause of deaths, results from multivariable modelling[a] (care home vs. hospital), England 1984–2010

Variable	Value	Time period 1984–92[a]	1993–2000	2001–10
Age, years	25–54	1.000	1.000	1.000
	55–64	1.088 (1.074 to 1.102)	0.992 (0.990 to 0.994)	0.994 (0.992 to 0.995)
	65–74	1.180 (1.166 to 1.193)	0.976 (0.975 to 0.978)	0.975 (0.974 to 0.977)
	75–84	1.386 (1.370 to 1.402)	0.958 (0.957 to 0.960)	0.957 (0.955 to 0.958)
	85+	1.695 (1.675 to 1.716)	0.939 (0.937 to 0.941)	0.942 (0.941 to 0.944)
Gender	Female	1.000	1.000	1.000
	Male	0.903 (0.899 to 0.908)	1.003 (1.002 to 1.003)	1.006 (1.005 to 1.007)
	Married	NA	1.000	1.000
	Widowed	NA	0.992 (0.991 to 0.993)	0.997 (0.996 to 0.998)
	Single	NA	0.987 (0.986 to 0.989)	0.994 (0.993 to 0.996)
	Divorced	NA	0.992 (0.990 to 0.994)	1.000 (0.999 to 1.002)
	NS/unknown	NA	0.988 (0.984 to 0.992)	1.003 (0.998 to 1.008)
Year of death	–	1.024 (1.022 to 1.025)	1.000 (1.000 to 1.001)	1.000 (1.000 to 1.000)[c]
IMD	Most deprived	1.000	1.000	1.000
	2	1.065 (1.034 to 1.097)	0.994 (0.992 to 0.996)	0.995 (0.993 to 0.997)
	3	1.094 (1.059 to 1.130)	0.989 (0.987 to 0.991)	0.992 (0.990 to 0.994)
	4	1.120 (1.083 to 1.158)	0.986 (0.984 to 0.988)	0.988 (0.986 to 0.990)
	5	1.122 (1.084 to 1.161)	0.986 (0.984 to 0.988)	0.988 (0.986 to 0.990)
Region	North West	1.000	1.000	1.000
	East England	0.863 (0.838 to 0.889)	1.012 (1.009 to 1.014)	1.007 (1.004 to 1.009)
	East Midlands	0.939 (0.912 to 0.967)	1.002 (0.999 to 1.005)	0.998 (0.996 to 1.001)
	London	0.713 (0.696 to 0.730)	1.024 (1.022 to 1.026)	1.020 (1.018 to 1.023)
	North East	0.904 (0.871 to 0.939)	0.992 (0.989 to 0.996)	0.995 (0.991 to 0.998)
	South Central	0.940 (0.910 to 0.971)	1.008 (1.005 to 1.011)	0.997 (0.994 to 1.000)
	South East Coast	0.999 (0.969 to 1.029)	0.999 (0.996 to 1.002)	1.000 (0.997 to 1.002)
	South West	1.034 (1.005 to 1.063)	0.988 (0.985 to 0.991)	0.986 (0.983 to 0.989)
	West Midlands	0.962 (0.936 to 0.989)	1.001 (0.999 to 1.004)	0.998 (0.995 to 1.000)
	Yorkshire and the Humber	0.939 (0.914 to 0.966)	1.003 (1.000 to 1.005)	0.999 (0.997 to 1.002)

NA, not available; NS, not specified.
a The *p*-values for individual variables were significant at the level of $p < 0.0001$.
b Hospital vs. other communal establishments. PR of > 1 indicates higher chance of hospital death; PR of < 1 indicates higher chance of care home death.
c The *p*-value = 0.012.

For neurological conditions, home or care home death compared with hospital death

Hospital deaths from neurological conditions were increasingly more likely with increasing age of death than with home death. The gap was more pronounced in the earlier period (PRs 0.802–1.031) than the later period (PRs 0.926–0.988 for 1993–2000; 0.943–0.995 for 2001–10) (*Table 22*). Care home compared with hospital deaths showed a similar age pattern across the time periods (PRs 1.032–1.245 for 1984–92;

TABLE 22 Proportion ratios (95% CI) of factors associated with place of neurological condition cause of deaths, derived from multivariable modelling[a] (home vs. hospital), England 1984–2010

		Time period		
Variable	Value	1984–92	1993–2000	2001–10
Age, years	25–54	1.000	1.000	1.000
	55–64	1.031 (0.999 to 1.063)	0.988 (0.971 to 1.005)	0.995 (0.986 to 1.003)
	65–74	0.894 (0.870 to 0.920)	0.952 (0.938 to 0.966)	0.974 (0.967 to 0.982)
	75–84	0.819 (0.798 to 0.841)	0.928 (0.915 to 0.942)	0.947 (0.940 to 0.954)
	85+	0.802 (0.779 to 0.824)	0.926 (0.912 to 0.940)	0.943 (0.935 to 0.950)
Gender	Female	1.000	1.000	1.000
	Male	0.947 (0.936 to 0.960)	0.972 (0.965 to 0.978)	0.976 (0.972 to 0.980)
	Married	NA	1.000	1.000
	Widowed	NA	0.976 (0.968 to 0.984)	0.965 (0.960 to 0.970)
	Single	NA	0.954 (0.943 to 0.965)	0.956 (0.950 to 0.963)
	Divorced	NA	0.970 (0.953 to 0.987)	0.959 (0.952 to 0.966)
	NS/unknown	NA	0.971 (0.939 to 1.005)	0.941 (0.917 to 0.965)
Year of death	–	1.031 (1.028 to1.033)	0.999 (0.997 to 1.000)[b]	1.000 (1.000 to 1.001)[b]
IMD	Most deprived	1.000	1.000	1.000
	2	1.052 (1.027 to 1.077)	1.000 (0.991 to 1.009)	1.007 (1.001 to 1.014)
	3	1.108 (1.081 to 1.136)	1.013 (1.003 to 1.022)	1.018 (1.011 to 1.025)
	4	1.156 (1.127 to 1.186)	1.024 (1.014 to 1.034)	1.024 (1.017 to 1.031)
	5	1.183 (1.152 to 1.214)	1.032 (1.022 to 1.042)	1.033 (1.026 to 1.040)
Region	North West	1.000	1.000	1.000
	East England	0.928 (0.899 to 0.959)	0.985 (0.973 to 0.997)	0.999 (0.992 to 1.007)
	East Midlands	0.966 (0.934 to 0.999)	0.996 (0.984 to 1.008)	0.999 (0.991 to 1.008)
	London	0.857 (0.831 to 0.883)	0.979 (0.969 to 0.990)	0.990 (0.983 to 0.998)
	North East	0.921 (0.883 to 0.960)	0.950 (0.933 to 0.966)	0.989 (0.979 to 0.998)
	South Central	0.966 (0.932 to 1.001)	0.987 (0.974 to 1.001)	1.001 (0.991 to 1.010)
	South East Coast	1.019 (0.987 to 1.051)	0.994 (0.982 to 1.007)	1.001 (0.993 to 1.009)
	South West	1.043 (1.013 to 1.075)	0.990 (0.978 to 1.002)	1.004 (0.996 to 1.013)
	West Midlands	0.995 (0.965 to 1.027)	0.987 (0.976 to 0.999)	0.998 (0.990 to 1.006)
	Yorkshire and the Humber	0.940 (0.911 to 0.970)	0.991 (0.979 to 1.002)	0.989 (0.981 to 0.997)

NA, not available; NS, not specified.
a The *p*-values for individual variables were significant at the level of $p < 0.0001$. PR of > 1 indicates higher chance of dying in home; PR of < 1 indicates higher chance of dying in hospital.
b The *p*-value > 0.05.

0.938–0.980 for 1993–2000; 0.927–0.993 for 2001–10) (*Table 23*). Men who died from neurological conditions had a higher risk of dying in hospital than in home (PRs 0.947–0.976) or care home (PRs 1.012–1.019 in 1993–2010), although in 1984–92 these men were more likely to have died in a care home (PR 0.882, 95% CI 0.870 to 0.893). Divorced, single and widowed individuals had a higher chance of a hospital death in the model contrasting hospital with home (PRs 0.941–0.976) and

TABLE 23 Proportion ratios (95% CI) of factors associated with place of neurological condition cause of deaths, results from multivariable modelling[a] (care home vs. hospital), England 1984–2010

		Time period		
Variable	Value	1984–92[b]	1993–2000	2001–10
Age, years	25–54	1.000	1.000	1.000
	55–64	1.032 (0.994 to 1.070)	0.980 (0.966 to 0.994)	0.993 (0.986 to 0.999)
	65–74	1.060 (1.024 to 1.096)	0.963 (0.951 to 0.975)	0.962 (0.956 to 0.968)
	75–84	1.167 (1.129 to 1.207)	0.944 (0.933 to 0.956)	0.937 (0.932 to 0.943)
	85+	1.245 (1.202 to 1.289)	0.938 (0.926 to 0.950)	0.927 (0.922 to 0.933)
Gender	Female	1.000	1.000	1.000
	Male	0.882 (0.870 to 0.893)	1.012 (1.008 to 1.015)	1.019 (1.016 to 1.022)
	Married	NA	1.000	1.000
	Widowed	NA	0.989 (0.985 to 0.993)	0.982 (0.979 to 0.985)
	Single	NA	0.984 (0.978 to 0.990)	0.986 (0.981 to 0.991)
	Divorced	NA	0.985 (0.976 to 0.993)	0.990 (0.985 to 0.995)
	NS/unknown	NA	0.993 (0.977 to 1.010)	0.994 (0.976 to 1.013)
Year of death	–	1.042 (1.039 to 1.045)	0.998 (0.997 to 0.999)	1.000 (1.000 to 1.001)[c]
IMD	Most deprived	1.000	1.000	1.000
	2	1.055 (1.025 to 1.085)	0.990 (0.983 to 0.998)	0.992 (0.987 to 0.998)
	3	1.109 (1.077 to 1.143)	0.985 (0.978 to 0.992)	0.991 (0.986 to 0.996)
	4	1.128 (1.096 to 1.162)	0.975 (0.968 to 0.982)	0.981 (0.975 to 0.986)
	5	1.123 (1.089 to 1.157)	0.973 (0.966 to 0.980)	0.983 (0.978 to 0.989)
Region	North West	1.000	1.000	1.000
	East England	0.866 (0.837 to 0.896)	1.022 (1.013 to 1.031)	1.006 (1.000 to 1.012)
	East Midlands	0.938 (0.906 to 0.971)	1.010 (1.001 to 1.019)	0.990 (0.983 to 0.996)
	London	0.772 (0.748 to 0.796)	1.056 (1.047 to 1.065)	1.031 (1.025 to 1.037)
	North East	0.864 (0.829 to 0.901)	0.986 (0.974 to 0.999)	0.990 (0.982 to 0.998)
	South Central	0.955 (0.920 to 0.992)	1.017 (1.007 to 1.027)	0.997 (0.989 to 1.004)
	South East Coast	0.996 (0.964 to 1.029)	1.004 (0.995 to 1.013)	0.995 (0.989 to 1.002)
	South West	1.014 (0.982 to 1.047)	0.991 (0.982 to 1.000)	0.975 (0.968 to 0.981)
	West Midlands	0.933 (0.903 to 0.964)	1.007 (0.998 to 1.016)	0.990 (0.983 to 0.996)
	Yorkshire and the Humber	0.918 (0.889 to 0.948)	1.012 (1.004 to 1.021)	0.992 (0.985 to 0.998)

NA, not available; NS, not specified.
a The *p*-values for individual variables were significant at the level of $p < 0.0001$.
b Hospital vs. other communal establishments. PR of > 1 indicates higher chance of hospital death; PR of < 1 indicates higher chance of care home death.
c The *p*-value = 0.10.

a higher chance of a care home death in the model contrasting hospital with care home (PRs 0.982–0.994). Chance of home death remained stable from 1993 to 2010 but increased [PR 1.031 (95% CI 1.028 to 1.033)] in the period of 1984–92; however, hospital death showed an increasing trend in the period of 1984–92 [PR 1.042 (95% 1.039 to 1.045)] compared with care home death.

Home death was consistently more likely than hospital death in the whole study period, along with less area deprivation (PRs 1.000–1.183). Care home death compared with hospital death showed different patterns in the periods of 1984–92 and 1993–2010: in the earlier period, hospital death was more likely (PRs 1.055–1.123), whereas in the later periods, care home death was more likely (PRs 0.973–0.992). Six out of nine regions had a higher chance of home death than hospital death than the North West region over the whole study period (PRs 0.857–0.999); only the North East region showed a consistent tendency of care home death in all three periods (PRs 0.864–0.990).

Over the study period, the regional variation in PoD was reducing. For example, the PR range of the PoD in home compared with hospital was 0.985 to 0.996 in 1993–2000, which changed to 0.989 to 1.004 in 2001–10; the PRs derived from care home compared with hospital models ranged from 0.981 to 1.056 in 1993–2000 to 0.009 to 1.006 in 2001–10. In the early period (1984–92), deaths were more likely to occur in hospital in most of the regions other than the South West, where the deaths in the earlier period were more likely in care homes.

For chronic obstructive pulmonary diseases, home or care home death compared with hospital death

In COPD, age was associated with an increased chance of hospital death compared with home death (PRs 0.905–0.965 in 1984–92; 0.957–0.986 in 1993–2000; 0.939–0.986 in 2001–10) (*Table 24*); in hospital compared with care home death models, similar age-PoD association was observed (*Table 25*). Men had an increased chance of dying in home throughout the three time periods [PR 1.032 (95% CI 1.024 to 1.041) in 1984–92; 1.011 (95% CI 1.009 to 1.013) in 1993–2000; 1.014 (95% CI 1.012 to 1.015) in 2001–10]. Widowed people who died from COPD were more likely to die in hospital (PRs 0.993–0.995), and divorced people were more likely to have died at home (PRs 1.002–1.009). There was a slightly increased trend for COPD patients dying in hospital over the year, which continued until 2000 [(PR 0.989, 95% CI 0.987 to 0.990) in 1984–92; 0.999 (95% CI 0.999 to 1.000) in 1993–2000]; in the period of 2001–10, the increasing trend was no longer significant ($p > 0.05$). Less area deprivation was associated with higher chance of home death (PRs 0.997–1.028 for 1984–92; 1.000–1.003 for 1993–2000; 0.998–1.002 for 2001–10). For the period of 1993–2000, patients with COPD who resided in North West region had the lowest chance of home death (PRs 1.000–1.013). In 1984–92, only East England, London and Yorkshire and the Humber had a lower chance of home death than North West regions (PRs 0.948–0.982).

Men had a higher chance of care home death in 1984–2000 (PRs 0.909–0.999) but an increased likelihood of hospital death in 2001–10 (PR 1.001, 95% CI 1.000 to 1.002) (*Table 26*). Married people had a consistent higher chance of hospital death than single, widowed or divorced people (PRs 0.973–0.989). There was an increased chance of hospital deaths and the trend persisted until 2000 (PRs 1.012–1.001), then became nearly a plateau but was still statistically significant ($p = 0.003$). Increased area deprivation was positively associated with probability of hospital death in 1984–92 (PRs 1.033–1.081); however, the direction of association turned into positive for care home death post-1992 (PRs 0.985–0.996). During the period of 1984 to 1992, seven out of nine regions had higher chance of care home death than in North West region (PRs 0.814–0.986); after 1992, only East England and North East regions remained to have higher chance of care home death but the contrasts were much less pronounced than for the earlier period in North West region (PRs 0.989–0.999).

TABLE 24 Proportion ratios (95% CI) of factors associated with place of COPD cause of deaths, derived from multivariable modelling[a] (home vs. hospital), England 1984–2010

Variable	Value	Time period		
		1984–92	1993–2000	2001–10
Age, years	25–54	1.000	1.000	1.000
	55–64	0.965 (0.936 to 0.995)	0.986 (0.979 to 0.993)	0.986 (0.980 to 0.992)
	65–74	0.943 (0.916 to 0.970)	0.980 (0.973 to 0.987)	0.967 (0.961 to 0.973)
	75–84	0.923 (0.897 to 0.950)	0.971 (0.964 to 0.978)	0.954 (0.948 to 0.960)
	85+	0.905 (0.878 to 0.932)	0.957 (0.950 to 0.964)	0.939 (0.933 to 0.945)
Gender	Female	1.000	1.000	1.000
	Male	1.032 (1.024 to 1.041)	1.011 (1.009 to 1.013)	1.014 (1.012 to 1.015)
	Married	NA	1.000	1.000
	Widowed	NA	0.993 (0.991 to 0.995)	0.995 (0.993 to 0.997)
	Single	NA	0.998 (0.994 to 1.002)	1.006 (1.003 to 1.010)
	Divorced	NA	1.002 (0.999 to 1.006)	1.009 (1.006 to 1.012)
	NS/unknown	NA	1.029 (1.020 to 1.039)	1.027 (1.017 to 1.036)
Year of death	–	0.989 (0.987 to 0.990)	0.999 (0.999 to 1.000)	1.000 (1.000 to 1.000)[b]
IMD	Most deprived	1.000	1.000[b]	1.000[c]
	2	0.997 (0.986 to 1.008)	1.001 (0.999 to 1.004)	0.998 (0.995 to 1.000)
	3	1.014 (1.002 to 1.027)	1.000 (0.997 to 1.003)	1.000 (0.998 to 1.002)
	4	1.019 (1.005 to 1.033)	1.001 (0.998 to 1.004)	1.002 (0.999 to 1.004)
	5	1.028 (1.013 to 1.043)	1.003 (1.000 to 1.007)	1.002 (1.000 to 1.005)
Region	North West	1.000	1.000	1.000
	East England	0.982 (0.965 to 1.000)	1.008 (1.004 to 1.012)	1.005 (1.002 to 1.008)
	East Midlands	1.026 (1.008 to 1.044)	1.005 (1.001 to 1.009)	1.005 (1.002 to 1.009)
	London	0.948 (0.934 to 0.962)	1.005 (1.001 to 1.008)	1.004 (1.001 to 1.006)
	North East	1.050 (1.031 to 1.069)	1.000 (0.995 to 1.005)	1.006 (1.002 to 1.009)
	South Central	1.028 (1.008 to 1.049)	1.012 (1.008 to 1.016)	1.009 (1.006 to 1.013)
	South East Coast	1.012 (0.994 to 1.030)	1.009 (1.005 to 1.013)	1.004 (1.001 to 1.007)
	South West	1.031 (1.013 to 1.049)	1.010 (1.006 to 1.014)	1.013 (1.009 to 1.016)
	West Midlands	1.054 (1.038 to 1.071)	1.008 (1.004 to 1.011)	1.003 (1.000 to 1.006)
	Yorkshire and the Humber	0.972 (0.957 to 0.987)	1.008 (1.005 to 1.012)	1.011 (1.008 to 1.014)

NA, not available; NS, not specified.

a The *p*-values for individual variables were significant at the level of $p < 0.0001$. PR of > 1 indicates higher chance of dying in home; PR of < 1 indicates higher chance of dying in hospital.

b The *p*-value > 0.05.

c The *p*-value $= 0.004$.

TABLE 25 Proportion ratios (95% CI) of factors associated with place of COPD condition cause of deaths, results from multivariable modelling[a] (care home vs. hospital), England 1984–2010

Variable	Value	Time period		
		1984–92[b]	1993–2000	2001–10
Age, years	25–54	1.000	1.000	1.000
	55–64	0.993 (0.969 to 1.017)	0.997 (0.993 to 1.001)	0.998 (0.995 to 1.001)
	65–74	1.078 (1.053 to 1.104)	0.991 (0.987 to 0.996)	0.993 (0.990 to 0.996)
	75–84	1.310 (1.279 to 1.342)	0.974 (0.970 to 0.978)	0.981 (0.978 to 0.984)
	85+	1.688 (1.646 to 1.732)	0.946 (0.942 to 0.950)	0.959 (0.956 to 0.962)
Gender	Female	1.000	1.000[c]	1.000
	Male	0.909 (0.901 to 0.917)	0.999 (0.998 to 1.001)	1.001 (1.000 to 1.002)
	Married	NA	1.000	1.000
	Widowed	NA	0.985 (0.984 to 0.987)	0.989 (0.988 to 0.990)
	Single	NA	0.973 (0.970 to 0.975)	0.982 (0.980 to 0.984)
	Divorced	NA	0.985 (0.983 to 0.987)	0.992 (0.991 to 0.994)
	NS/unknown	NA	0.980 (0.974 to 0.986)	0.984 (0.978 to 0.989)
Year of death	–	1.012 (1.010 to 1.013)	1.001 (1.001 to 1.002)	1.000 (1.000 to 1.000)[d]
IMD	Most deprived	1.000	1.000	1.000
	2	1.033 (1.015 to 1.052)	0.995 (0.994 to 0.997)	0.996 (0.995 to 0.998)
	3	1.067 (1.046 to 1.089)	0.991 (0.989 to 0.993)	0.994 (0.992 to 0.996)
	4	1.081 (1.059 to 1.104)	0.987 (0.985 to 0.990)	0.990 (0.989 to 0.992)
	5	1.079 (1.056 to 1.103)	0.985 (0.983 to 0.988)	0.989 (0.988 to 0.991)
Region	North West	1.000	1.000	1.000
	East England	0.896 (0.874 to 0.918)	1.011 (1.008 to 1.014)	1.003 (1.001 to 1.005)
	East Midlands	0.976 (0.952 to 1.001)	0.998 (0.995 to 1.001)	0.999 (0.997 to 1.001)
	London	0.814 (0.797 to 0.832)	1.021 (1.019 to 1.023)	1.012 (1.010 to 1.014)
	North East	0.970 (0.942 to 0.999)	0.989 (0.985 to 0.993)	0.994 (0.992 to 0.997)
	South Central	0.986 (0.958 to 1.014)	1.010 (1.007 to 1.013)	1.002 (1.000 to 1.005)
	South East Coast	1.017 (0.991 to 1.043)	0.999 (0.995 to 1.002)	0.999 (0.997 to 1.001)
	South West	1.002 (0.978 to 1.027)	0.993 (0.990 to 0.996)	0.994 (0.992 to 0.996)
	West Midlands	0.946 (0.924 to 0.969)	1.002 (0.999 to 1.004)	1.000 (0.998 to 1.002)
	Yorkshire and the Humber	0.946 (0.924 to 0.968)	1.002 (1.000 to 1.005)	0.997 (0.995 to 1.000)

a The *p*-values for individual variables were significant at the level of $p < 0.0001$.
b Hospital vs. other communal establishments. PR of > 1 indicates higher chance of hospital death; PR of < 1 indicates higher chance of care home death.
c The *p*-value = 0.34.
d The *p*-value = 0.003.

TABLE 26 Proportion ratios (95% CI) of the association of selected holiday period and PoD by cause of death, derived from multivariable modelling[a] (home vs. hospital), England 1984–2010

		Time period		
Cause of death	**Holiday period**	**1984–92**	**1993–2000**	**2001–10**
All	Normal	1.000	1.000	1.000
	Christmas	0.999 (0.994 to 1.004)	1.000 (0.999 to 1.002)	1.000 (0.998 to 1.001)
	Easter	0.995 (0.990 to 1.001)	1.000 (0.998 to 1.001)	0.998 (0.997 to 0.999)
	New Year	1.016 (1.009 to 1.023)	1.004 (1.002 to 1.005)	1.002 (1.000 to 1.003)
Non-cancer	Normal	1.000	1.000	1.000
	Christmas	0.995 (0.989 to 1.001)	1.002 (1.001 to 1.004)	1.000 (0.999 to 1.001)
	Easter	0.994 (0.987 to 1.000)	0.999 (0.998 to 1.001)	0.998 (0.997 to 1.000)
	New Year	1.029 (1.021 to 1.037)	1.007 (1.006 to 1.009)	1.007 (1.005 to 1.009)
Cancer	Normal	1.000	1.000	1.000
	Christmas	1.019 (1.009 to 1.029)	0.999 (0.996 to 1.002)	1.003 (1.000 to 1.006)
	Easter	1.001 (0.990 to 1.011)	1.002 (0.999 to 1.005)	0.999 (0.997 to 1.002)
	New Year	0.989 (0.976 to 1.003)	0.996 (0.992 to 0.999)	0.990 (0.987 to 0.994)
CVD	Normal	1.000	1.000	1.000
	Christmas	0.996 (0.987 to 1.004)	1.004 (1.001 to 1.006)	1.001 (0.998 to 1.003)
	Easter	0.999 (0.990 to 1.008)	0.999 (0.997 to 1.002)	0.999 (0.996 to 1.001)
	New Year	1.035 (1.024 to 1.046)	1.011 (1.009 to 1.014)	1.010 (1.007 to 1.013)
CBD	Normal	1.000[b]	1.000[b]	1.000[b]
	Christmas	0.983 (0.967 to 0.999)	0.997 (0.994 to 1.001)	0.999 (0.995 to 1.002)
	Easter	0.990 (0.973 to 1.008)	0.997 (0.993 to 1.001)	0.998 (0.995 to 1.002)
	New Year	0.987 (0.966 to 1.009)	1.001 (0.997 to 1.005)	1.004 (0.999 to 1.008)
Neurological conditions	Normal	1.000	1.000	1.000
	Christmas	1.052 (1.012 to 1.093)	1.003 (0.983 to 1.023)	0.994 (0.981 to 1.006)
	Easter	0.960 (0.918 to 1.005)	0.992 (0.968 to 1.016)	1.008 (0.995 to 1.022)
	New Year	0.946 (0.896 to 0.998)	0.967 (0.940 to 0.996)	0.983 (0.967 to 0.999)
COPD	Normal	1.000	1.000[b]	1.000[b]
	Christmas	0.975 (0.953 to 0.998)	0.998 (0.993 to 1.002)	1.002 (0.997 to 1.006)
	Easter	0.975 (0.949 to 1.002)	0.997 (0.991 to 1.003)	0.998 (0.993 to 1.003)
	New Year	1.023 (0.995 to 1.053)	1.003 (0.998 to 1.009)	1.004 (0.999 to 1.010)

a PRs of > 1 indicates higher chance of hospital death; PR of < 1 lower chance of death in hospital.
b The p-value for overall comparison is > 0.05, all other p-values significant at the level of $p < 0.05$.

Variations in place of death by holiday period and season, home or care home death compared with hospital death

Compared with normal periods, there was a slightly increased chance of hospital death compared with home death during the Christmas period for non-cancer deaths in 1993–2000 [PR 1.002 (95% CI 1.001 to 1.004)], cancer deaths in 1984–92 [PR 1.019 (95% CI 1.009 to 1.029)] and in 2001–10 [PR 1.003 (95% CI 1.000 to 1.006)], CVD deaths in 1993–2000 [PR 1.004 (95% CI 1.001 to 1.006)] and neurological condition deaths in 1984–92 [PR 1.052 (1.012 to 1.093)] (see *Table 26*). The probability of home death increased during the Christmas period for COPD deaths in 1984–92 [PR 0.975 (95% CI 0.953 to 0.998)]. No statistically significant difference of the death between Christmas and normal period was found for CBD deaths in all three periods ($p > 0.05$).

A reduced chance of hospital deaths during the Easter period was observed for all CoD in 2001–10 [PR 0.998 (95% CI 0.997 to 0.999)], non-cancer death in 1984–92 [PR 0.994 (95% CI 0.987 to 1.000)] and in 2001–10 [PR 0.998 (95% CI 0.997 to 1.000)]. None of the other causes of death in the observation periods appeared to be statistically different from the normal period. The New Year period had increased hospital deaths for the whole study period (PRs 1.002–1.016) for all-cause death, non-cancer CoD (PRs 1.007–1.029), CVD CoD (PRs 1.010–1.035). However, there was an increased chance of dying at home for cancer in 1993–2000 [PR 0.996 (95% CI 0.992 to 0.999)] and in 2001–10 [PR 0.990 (95% CI 0.987 to 0.994)], and for neurological conditions in 1984–2010 (PRs 0.946–0.983).

With the season 'spring' as the reference group, all CoD during the summer season had a lower chance of hospital death in 1984–92 (PR 0.992, 95% CI 0.990 to 0.995), but the chance of hospital death increased to the similar level with the spring (PR 1.000, 95% CI 0.999 to 1.000) and up to the period 2001–10, the probability of hospital death in summer was higher than in spring for all-cause death (PR 1.002, 95% CI 1.001 to 1.002) (*Table 27*). A similar pattern was observed for all non-cancer deaths: 0.998 in 1984–92 to 0.999 in 1993–2000, and to 1.000 in 2001–10. Cancer deaths were less likely in hospital (PR 0.998, 95% CI 0.997 to 1.000) but more likely in hospital in 2001–10 (PR 1.002, 95% CI 1.001 to 1.003). Home deaths during summer were more likely for CVD deaths in 1984–2000 (PRs 0.983–0.998). During the autumn, deaths from all causes, non-cancer, CVD and COPD causes were more likely to have occurred in hospital for all three study periods (PRs 1.001–1.007 for all and non-cancer; PRs 1.001–1.005 for CVD; PRs 1.003–1.019 for COPD). Cancer deaths had a higher chance of occurring in hospital in 1984–92 (PR 1.005, 95% CI 1.001 to 1.009) and in 2001–10 (PR 1.002, 95% CI 1.001 to 1.003) but were more likely to be a home death in 1993–2000 (PR 0.998, 95% CI 0.996 to 0.999). Higher winter hospital deaths were exhibited for all causes, non-cancer and CVD causes of death (PRs 1.000–1.011 for all cause; PRs 1.002–1.018 for non-cancer; PRs 1.004–1.023 for CVD). Cancer showed higher home death in winter for the period of 1993–2010 (PRs 0.997–0.998), higher hospital death during winter for CBD presented only in the period of 1984–2000 (PRs 1.002–1.012). The temporal variation for hospital compared with home death tended to get smaller from the earlier period to the later period.

The care home model compared with the hospital model showed an increased chance of hospital death in 1984–92 during the Christmas period for all-cause, non-cancer, cancer, CVD and CBD deaths (PRs 1.023–1.034); for the later period (1993–2010), the pattern turned to an increased chance of care home death for all-cause, non-cancer and cancer deaths (PRs 0.995–0.998) and non-significant compared with the normal period for the remaining CoD (*Table 28*). No significant difference in hospital compared with care home death was observed during the Easter period for the majority of the selected CoD in the earlier period (1984–2000), but an slightly increased likelihood of care home death during the Easter period was revealed in 2001–10 for all causes, non-cancer, CBD and COPD (PRs 1.002–1.003). Cancer deaths in care homes during the Easter period were slightly increased in 1984–92 (PR 0.987, 95% CI 0.975 to 0.998). Non-cancer and CVD deaths in 1984–92, all causes, non-cancer, CVD and COPD deaths in 2001–10 had a higher chance of hospital compared with care home death during the New Year period (PRs 1.001–1.017).

TABLE 27 Proportion ratios (95% CI) of the association of season and PoD by cause of death, derived from multivariable modelling[a] (home vs. hospital), England 1984–2010

Cause of death	Season	Time period 1984–92	1993–2000	2001–10
All	Spring	1.000	1.000	1.000
	Summer	0.992 (0.990 to 0.995)	1.000 (0.999 to 1.000)	1.002 (1.001 to 1.002)
	Autumn	1.007 (1.005 to 1.010)	1.001 (1.000 to 1.001)	1.002 (1.002 to 1.003)
	Winter	1.011 (1.009 to 1.013)	1.000 (1.000 to 1.001)	1.000 (1.000 to 1.001)
Non-cancer	Spring	1.000	1.000	1.000
	Summer	0.988 (0.985 to 0.991)	0.999 (0.999 to 1.000)	1.000 (1.000 to 1.001)
	Autumn	1.007 (1.004 to 1.010)	1.001 (1.001 to 1.002)	1.002 (1.001 to 1.002)
	Winter	1.018 (1.015 to 1.021)	1.002 (1.001 to 1.003)	1.002 (1.001 to 1.002)
Cancer	Spring	1.000	1.000	1.000
	Summer	0.997 (0.993 to 1.001)	0.998 (0.997 to 1.000)	1.002 (1.001 to 1.003)
	Autumn	1.005 (1.001 to 1.009)	0.998 (0.996 to 0.999)	1.002 (1.001 to 1.003)
	Winter	0.998 (0.994 to 1.002)	0.997 (0.996 to 0.998)	0.998 (0.997 to 0.999)
CVD	Spring	1.000	1.000	1.000
	Summer	0.983 (0.979 to 0.987)	0.998 (0.997 to 0.999)	1.000 (0.999 to 1.001)
	Autumn	1.005 (1.001 to 1.008)	1.001 (1.000 to 1.002)	1.002 (1.001 to 1.002)
	Winter	1.023 (1.020 to 1.027)	1.004 (1.003 to 1.005)	1.004 (1.003 to 1.005)
CBD	Spring	1.000	1.000[b]	1.000[b]
	Summer	0.998 (0.991 to 1.005)	1.001 (0.999 to 1.002)	0.999 (0.998 to 1.001)
	Autumn	1.003 (0.996 to 1.009)	1.002 (1.000 to 1.003)	1.001 (0.999 to 1.002)
	Winter	1.012 (1.005 to 1.018)	1.002 (1.000 to 1.003)	1.000 (0.999 to 1.001)
Neurological conditions	Spring	1.000[b]	1.000[b]	1.000
	Summer	0.999 (0.981 to 1.018)	1.006 (0.996 to 1.015)	1.007 (1.002 to 1.012)
	Autumn	1.003 (0.986 to 1.021)	1.005 (0.996 to 1.015)	1.002 (0.997 to 1.007)
	Winter	0.990 (0.973 to 1.007)	1.001 (0.993 to 1.010)	1.000 (0.995 to 1.005)
COPD	Spring	1.000	1.000	1.000
	Summer	1.006 (0.994 to 1.017)	1.001 (0.999 to 1.004)	1.002 (0.999 to 1.004)
	Autumn	1.019 (1.007 to 1.030)	1.003 (1.000 to 1.005)	1.005 (1.003 to 1.007)
	Winter	1.004 (0.994 to 1.014)	0.997 (0.995 to 0.999)	1.000 (0.998 to 1.001)

a PRs of > 1 indicate a higher chance of hospital death; PRs of < 1 lower chance of death in hospital.
b The *p*-value for overall comparison is > 0.05, all other *p*-values are significant at the level of $p < 0.05$.

TABLE 28 Proportion ratios (95% CI) of the association of selected holiday period and PoD by cause of death, derived from multivariable modelling[a] (care home vs. hospital), England 1984–2010

		Time period		
Cause of death	Holiday period	1984–92[b]	1993–2000	2001–10
All	Normal	1.000	1.000	1.000
	Christmas	1.028 (1.022 to 1.034)	0.998 (0.997 to 0.999)	0.998 (0.997 to 0.998)
	Easter	0.999 (0.992 to 1.005)	1.000 (0.999 to 1.001)	1.002 (1.001 to 1.003)
	New Year	1.007 (0.999 to 1.014)	0.998 (0.997 to 0.999)	1.001 (1.000 to 1.002)
Non-cancer	Normal	1.000	1.000	1.000
	Christmas	1.034 (1.027 to 1.040)	0.998 (0.997 to 0.999)	0.998 (0.997 to 0.999)
	Easter	1.004 (0.997 to 1.011)	1.000 (0.999 to 1.001)	1.002 (1.001 to 1.003)
	New Year	1.017 (1.008 to 1.025)	0.998 (0.997 to 0.999)	1.001 (1.000 to 1.002)
Cancer	Normal	1.000	1.000	1.000
	Christmas	1.028 (1.017 to 1.040)	0.998 (0.996 to 0.999)	0.995 (0.994 to 0.997)
	Easter	0.987 (0.975 to 0.998)	0.998 (0.996 to 1.000)	1.000 (0.999 to 1.002)
	New Year	0.995 (0.980 to 1.010)	0.999 (0.996 to 1.001)	1.001 (0.999 to 1.003)
CVD	Normal	1.000	1.000[c]	1.000[c]
	Christmas	1.023 (1.012 to 1.034)	1.000 (0.998 to 1.001)	0.999 (0.997 to 1.000)
	Easter	1.014 (1.003 to 1.025)	0.999 (0.998 to 1.001)	0.999 (0.998 to 1.000)
	New Year	1.015 (1.002 to 1.029)	0.998 (0.997 to 1.000)	1.001 (1.000 to 1.003)
CBD	Normal	1.000	1.000[b]	1.000
	Christmas	1.034 (1.019 to 1.048)	1.000 (0.998 to 1.003)	0.997 (0.995 to 1.000)
	Easter	0.998 (0.983 to 1.014)	1.000 (0.997 to 1.002)	1.003 (1.000 to 1.005)
	New Year	1.015 (0.996 to 1.034)	1.001 (0.998 to 1.004)	0.999 (0.996 to 1.003)
Neurological conditions	Normal	1.000[c]	1.000[c]	1.000[c]
	Christmas	1.033 (0.995 to 1.073)	0.994 (0.984 to 1.004)	0.999 (0.990 to 1.008)
	Easter	0.970 (0.928 to 1.013)	0.998 (0.986 to 1.010)	1.004 (0.995 to 1.014)
	New Year	0.975 (0.928 to 1.024)	0.994 (0.980 to 1.008)	0.999 (0.988 to 1.010)
COPD	Normal	1.000[c]	1.000[c]	1.000
	Christmas	1.010 (0.986 to 1.034)	1.001 (0.998 to 1.003)	1.001 (0.999 to 1.004)
	Easter	1.002 (0.975 to 1.030)	0.999 (0.995 to 1.003)	1.003 (1.000 to 1.006)
	New Year	0.972 (0.944 to 1.001)	1.002 (0.999 to 1.005)	1.003 (1.000 to 1.006)

a PRs of > 1 indicate a higher change of hospital death; PRs of < 1 indicate a lower chance of death in hospital.
b Hospital vs. other communal establishments.
c The p-value for overall comparison is > 0.05; all other p-values are significant at the level of $p < 0.05$.

In 1984–92, non-cancer deaths was the only CoD category that had a higher chance of dying in care home during the summer [PR 0.995 (95% CI 0.993 to 0.998)] (*Table 29*). There was a slightly higher chance of death in hospital for those who died during the winter from all, non-cancer, CVD and CBD CoDs in 1984–92 (PRs 1.008–1.013). In the period of 1993–2010, winter deaths were slightly more likely to occur in care homes (PRs 0.998–0.999) for all, non-cancer, and CBD CoDs, contrasting with the higher hospital death in the earlier period.

TABLE 29 Proportion ratios (95% CI) of the association of season and PoD by cause of death, derived from multivariable modelling[a] (care home vs. hospital), England 1984–2010

		Time period		
Cause of death	Season	1984–92[b]	1993–2000	2001–10
All	Spring	1.000	1.000	1.000
	Summer	1.000 (0.998 to 1.003)	1.000 (0.999 to 1.000)	0.999 (0.998 to 0.999)
	Autumn	1.005 (1.002 to 1.007)	0.999 (0.999 to 1.000)	0.997 (0.997 to 0.998)
	Winter	1.008 (1.005 to 1.010)	0.998 (0.998 to 0.998)	0.998 (0.998 to 0.999)
Non-cancer	Spring	1.000	1.000	1.000
	Summer	0.995 (0.993 to 0.998)	0.999 (0.999 to 1.000)	0.999 (0.998 to 0.999)
	Autumn	0.998 (0.995 to 1.001)	0.999 (0.999 to 0.999)	0.997 (0.997 to 0.998)
	Winter	1.013 (1.010 to 1.015)	0.998 (0.997 to 0.998)	0.998 (0.998 to 0.998)
Cancer	Spring	1.000	1.000	1.000
	Summer	1.000 (0.996 to 1.005)	1.001 (1.000 to 1.001)	0.999 (0.998 to 1.000)
	Autumn	1.013 (1.009 to 1.018)	1.001 (1.000 to 1.001)	0.999 (0.998 to 0.999)
	Winter	1.002 (0.997 to 1.006)	1.000 (0.999 to 1.000)	0.999 (0.999 to 1.000)
CVD	Spring	1.000	1.000	1.000
	Summer	0.999 (0.995 to 1.004)	0.999 (0.998 to 0.999)	0.999 (0.998 to 0.999)
	Autumn	0.997 (0.993 to 1.002)	1.000 (1.000 to 1.001)	0.999 (0.998 to 1.000)
	Winter	1.010 (1.006 to 1.015)	0.999 (0.999 to 1.000)	1.000 (0.999 to 1.000)
CBD	Spring	1.000	1.000[c]	1.000
	Summer	0.997 (0.991 to 1.004)	0.999(0.998 to 1.000)	0.999 (0.998 to 1.000)
	Autumn	0.999 (0.993 to 1.006)	0.999 (0.998 to 1.000)	0.997 (0.996 to 0.998)
	Winter	1.011 (1.005 to 1.017)	0.999 (0.998 to 1.000)	0.998 (0.997 to 0.999)
Neurological conditions	Spring	1.000[c]	1.000[c]	1.000[c]
	Summer	1.004 (0.987 to 1.022)	0.997 (0.993 to 1.002)	1.000 (0.996 to 1.003)
	Autumn	1.011 (0.994 to 1.029)	0.998 (0.994 to 1.003)	0.995 (0.992 to 0.999)
	Winter	1.004 (0.988 to 1.020)	0.998 (0.994 to 1.003)	0.998 (0.995 to 1.002)
COPD	Spring	1.000	1.000	1.000
	Summer	0.999 (0.988 to 1.011)	0.999 (0.998 to 1.001)	0.997 (0.996 to 0.998)
	Autumn	1.009 (0.997 to 1.021)	1.000 (0.998 to 1.001)	0.996 (0.994 to 0.997)
	Winter	0.990 (0.980 to 1.000)	1.003 (1.001 to 1.004)	0.999 (0.998 to 1.000)

a PRs of > 1 indicate a higher change of hospital death; PRs of < 1 indicate a lower chance of death in hospital.
b Hospital vs. other communal establishments.
c The *p*-value for overall comparison is > 0.05; all other *p*-values are significant at the level of $p < 0.05$.

Risk assessment

The results for the Wald tests, and the AUCs and their respective 95% CIs for PoD were as follows: all causes of deaths 0.553 [95% CI 0.551 to 0.554; $p < 0.001$, $\chi^2 = 3581.4$, degrees of freedom (df) = 1], non-cancer deaths 0.592 (95% CI 0.590 to 0.594; $p < 0.001$, $\chi^2 = 7579.1$, df = 1), cancer deaths 0.554 (95% CI 0.551 to 0.557; $p < 0.001$, $\chi^2 = 1098.1$, df = 1), CVD deaths 0.576 (95% CI 0.573 to 0.580; $p < 0.001$, $\chi^2 = 1815.3$, df = 1), CBD deaths 0.637 (95% CI 0.632 to 0.643; $p < 0.001$, $\chi^2 = 2344.0$, df = 1), deaths from neurological conditions 0.599 (95% CI 0.586 to 0.612; $p < 0.001$, $\chi^2 = 227.1$, df = 1) and deaths from COPD 0.552 (95% CI 0.551 to 0.554; $p < 0.001$, $\chi^2 = 3344.5$, df = 1) (*Figures 11–17*).

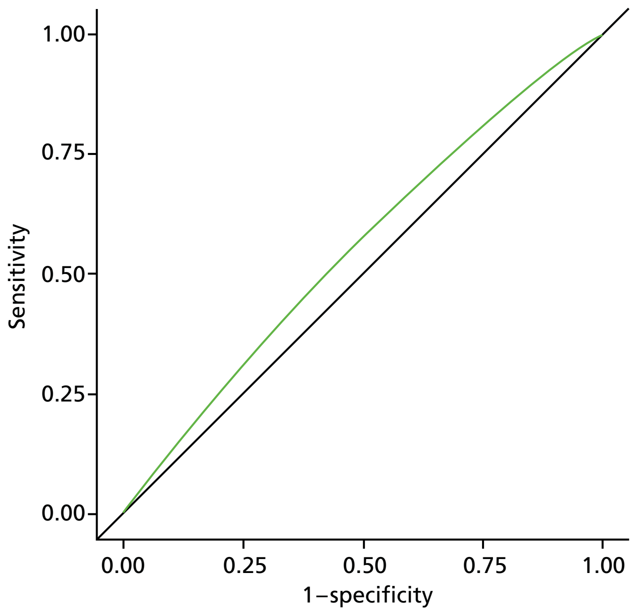

FIGURE 11 Receiver operating characteristic curve of risk assessment model for PoD in all-cause deaths, AUC = 0.5527.

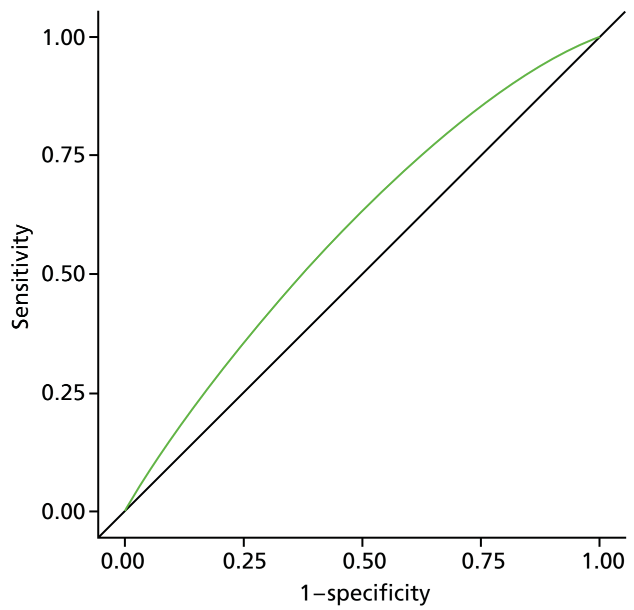

FIGURE 12 Receiver operating characteristic curve of risk assessment model for PoD in non-cancer, AUC = 0.5919.

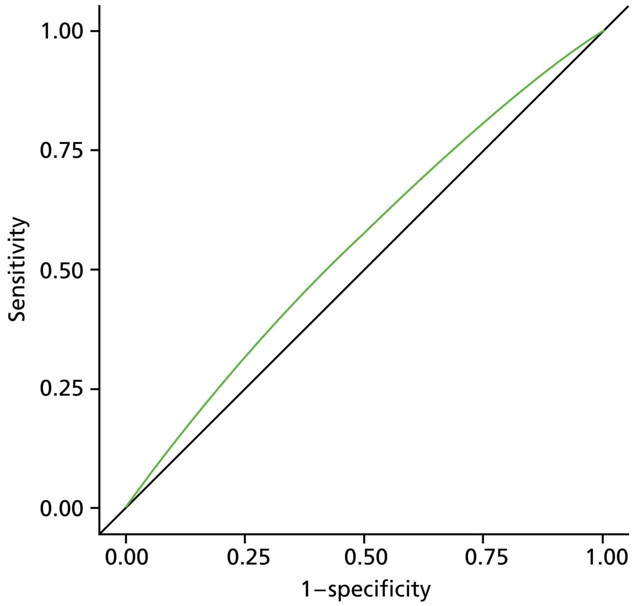

FIGURE 13 Receiver operating characteristic curve of risk assessment model for PoD in cancer, AUC = 0.5540.

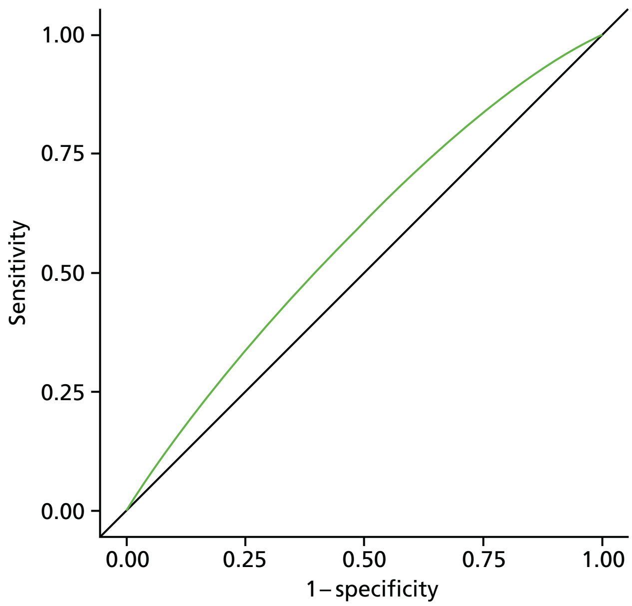

FIGURE 14 Receiver operating characteristic curve of risk assessment model for PoD in CVDs, AUC = 0.5763.

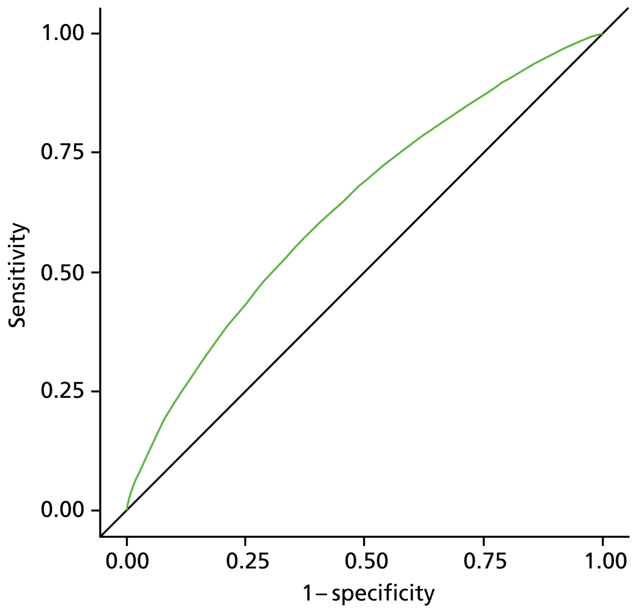

FIGURE 15 Receiver operating characteristic curve of risk assessment model for PoD in CBDs, AUC = 0.6371.

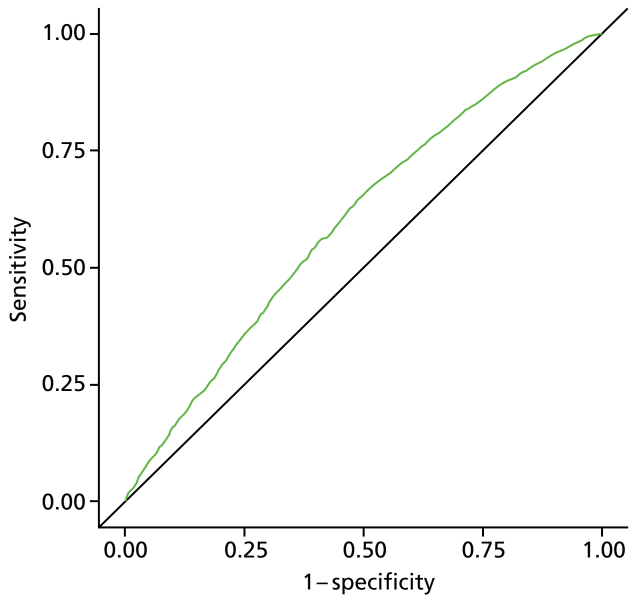

FIGURE 16 Receiver operating characteristic curve of risk assessment model for PoD in neurological conditions, AUC = 0.5988.

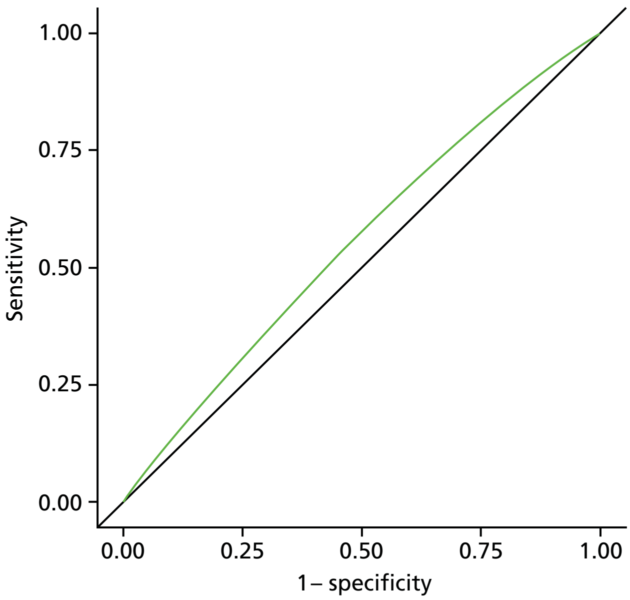

FIGURE 17 Receiver operating characteristic curve of risk assessment model for PoD in COPD, AUC = 0.5522.

Chapter 4 Discussion

Several findings emerge from this large-scale population-based study. First, there exist common patterns in PoD. Hospital remains the most common PoD in England throughout the whole period and irrespective of CoD. Overall, around three in five non-cancer deaths and one in two cancer deaths occurred in hospitals. Deaths in hospital showed a decreasing trend from 1984 to 2010. The findings are consistent with previous reports from England and also from the other countries.[9,12,18,21,50–52] Home and care home were the second or third most common PoD, depending on CoD. Hospice deaths were more likely among cancer deaths than in other causes of death; hospice was also the third most common place for cancer deaths. 'Home' and 'hospice' are often reported as the number one and number two choices, respectively, for the preferred PoD.[15,53] In England, over the past 30 years, cancer deaths are becoming more closely matched to people's preference for PoD.[18] By the end of 2010, hospice deaths accounted for 17.1% of all cancer deaths, in contrast, only 0.4% of non-cancer deaths occurred in a hospice. Deaths from neurological conditions are the second most likely to occur in a hospice. An encouraging finding is that both home and hospice deaths showed an increasing trend, mirroring the reduction in hospital deaths. However, one should not assume that home is always the most preferred PoD. Research found that some patients, particularly older people or patients with particular conditions, may well prefer to die in residential home or in hospital.[54–56]

Second, PoD showed wide regional variations, and this was the case regardless of how the region was defined (e.g. LA, electoral ward, PCO). London, a modern and populated metropolitan city, had persistently high rates of hospital deaths compared with other regions across different causes of death. A three-country comparative study found similar regional variation.[57] Understanding the mechanisms behind this variation is key to improving regional inequality in PoD. A population-based questionnaire involving 4081 respondents (over response rate 50.2%) explored the relationship between end-of-life care decisions and metropolitan environment.[58] Authors argued that the end-of-life care decision may be influenced by 'metropolitan issues' that include population environment, social environment and municipal-level determinants, and all of these are collectively affecting where a patient die. Although London and other metropolitan cities may share similar characteristics, it needs to be confirmed in future studies.

Third, this study has for the first time systematically analysed the temporal patterns in PoD in England, using individual-level data and multivariable modelling techniques. We found modest but consistent variations across a number of temporal dimensions. Over the study period, we observed long-term patterns showing a decreasing trend in hospital deaths and an increasing trend in home and hospice deaths. We have also seen an increase in care home deaths and this trend looks likely to continue. These findings are important for considering how our end-of-life care facilities and service delivery models are going to meet these changing patterns in PoD.[21,59] We also observed clear seasonal patterns in PoD, although the patterns seem to have become less clear in the most recent period. Autumn was associated with a higher chance of hospital deaths in most conditions but was not significant in all-cause deaths. CVD and non-cancer deaths were associated with a higher probability of hospital deaths in winter. We also identified a higher chance of hospital deaths during the Easter period and slightly higher chance of home death during Christmas. These were consistent with previous studies on seasonal and cyclic patterns in mortality.[24–28] The mechanisms and the drivers of these patterns are beyond the scope of this report but should be topics for future explorations. These newly identified temporal patterns offer opportunities for health-care professionals, policy-makers and decision-makers to rethink our service structure and service organisations.

Some social demographic characteristics have also been found to be associated with PoD. Independent of the CoD, increasing age was consistently a predictor of reduced chance of home or hospice death. Higher levels of area-based deprivation were also associated with a greater chance of hospital death. Marital status, which is used here as a proxy measure for social support, was also found to affect where a person dies. This is an important finding in relation to the ageing population and the increasing number of people living as single, widowed or divorced. End-of-life care will need to respond to these changing demographics.[49] Nevertheless, as the effect from such vast samples tends to be statistically significant, parties who would like to use the findings from this large-scale study should pay more attention to what constitutes meaningful effect sizes in their application contexts.

We intended to construct the risk assessment models to help to guide practice. Although we did not expect the models to reach sufficient performance at the individual level, the performance indicator (AUC range 0.5527 to 0.6371) suggested that none of the models (even the best for CBD death 0.6371) was strong enough to be considered useful compared with commonly accepted satisfactory criteria (AUC = 0.7).[48]

There are several reasons why we were able to explain only a small proportion of the variation in our model. Most importantly the data from death registration and our linkage to area-based sociodemographic factors did not include important determinants, in particular levels of service provision and individual-level sociodemographic variables. We consider the lack of local service provision data, in a reliable and consistent format, to be the most important piece of missing information. Service provision is an important factor in influencing PoD.[60] Information on local service provision, such as level of hospice provision, local hospital and nursing home beds, and community services (including out-of-hours care) would aid such analysis in the future. A recent Cochrane review has shown that home palliative care teams can double the odds of home death.[60]

Second, our sociodemographic variables were limited. Although an area-level measure of deprivation was used (the IMD), this is not an ideal (although is the best available) proxy for individual socioeconomic status owing to the 'ecological fallacy'.[61] Ecological fallacy occurs when a person is classified as deprived because they live in a deprived area when in fact they are not deprived, or vice versa, this occurs when using area-level measures, such as the IMD. Also, 'less-deprived area' does not necessarily mean a higher SES of the residents, as the 'income' domain of the IMD is based on the number of benefit claimant counts only. Despite this, the area-level modelling appears to be satisfactory, except for the cancer- and COPD-specific models. The other models using the selected variables can explain more than one-quarter of the variation in PoD, and for the CBD models the explained variation was nearly 40%.

Several limitations should be noted when interpreting the results from this report. The first is the issue of comparability. This is a study that covers a long period of time, the results across the time period may not be directly comparable owing to various reasons including ICD coding changes, recording practice changes and so on. In 2001, the ONS changed the disease classification system from the ICD-9[32] to the ICD-10[31] coding scheme. The impacts of these coding changes, particularly with regard to rule changes, vary by underlying CoD.[62] For example, the change to rule 3 allows a condition that is reported in either Part I or Part II of the death certificate to take precedence over the condition selected using the other coding rules if it is obviously a direct consequence of that condition. In ICD-10,[31] the list of conditions affected by rule 3 is more clearly defined than in ICD-9,[32] and is also broader in scope. One of the most significant changes concerns assigning pneumonia and bronchopneumonia as the underlying CoD.[63,64] Another comparability issue concerns PoD and its associated CoD. The reliability of CoDs may vary significantly by PoD. Deaths in hospital may have better accuracy than in other places of death.[65–67]

The way the variables are recorded may also have changed over time. For example, we planned to use country of birth as a proxy measure of ethnicity. However, when processing data, we found that the coding for country of birth in 2006 was unusable owing to a coding change in that year. There were a set of overlapping codes representing different country of birth in old and new coding schemes. This was noticed from the peculiar frequency distribution across the ethnicity. In addition, the analysis would benefit from a better individual-level measure of SES than is provided by the area-level IMD score/ranking. The social class variables contained in the database in its current format is hard to use. The value of this variable may be explored further in future studies.

Finally, the analysis was limited to some degree by the computationally highly demanding nature of this extremely large data set, prohibiting full exploration of the data. For most of the computational tasks, the computers had to be left running overnight. Two elements were extremely computationally demanding: data manipulation and individual-level modelling, particularly for large disease-group analysis. For example, it took a total of 13 hours, 33 minutes and 10 seconds for the computer to finish extracting 14 variables for seven defined causes of death from the full period of data (1984–2010). The time taken to run the individual-level modelling with six variables was 27 hours, 36 minutes and 7 seconds. The processor of the PC primarily used to complete the computational tasks was Intel® Xeon® CPU W3670 @3.20 GHz and RAM 4.00 GB. To make full use of this rich source of information and to be more efficient in the processing of this large number of data, the latest data-mining techniques or parallel computation facilities should be explored and incorporated.

There is tremendous value in having access to such a large-scale data set spanning 27 years to produce this report. There is still plenty of opportunity to enhance the value of the data set. For example, through data linkage we should be able to incorporate more information into the models therefore improving performance.

Chapter 5 Conclusions

In conclusion, this large-scale population-based study using 27 years of death certificate data for England found that the most common PoD remains hospital, followed by home or care home, depending on the CoD. The proportion of hospice deaths increased over time but varied significantly by CoD, from 17.1% in cancer, 3.5% in neurological conditions, to < 1% in other conditions. There were significant variations in PoD by region, with people from populated metropolitan areas (particularly London) being more likely to die in hospitals. PoD also differed by season and holiday period – with autumn and winter deaths (compared with spring deaths) having an increased chance of occurring in hospital, and a higher chance of home deaths during the Christmas period and hospital deaths during the New Year period compared with the normal period. There is evidence of inequality in PoD by age, marital status and deprivation. People who are aged 75+ years, single, divorced or widowed, and living in more deprived areas were more likely to die in hospital. Future studies are needed to confirm these findings, and the implication for service organisation and service delivery. The predictive performance of our risk assessment models was not satisfactory and needs further development taking into account service provision and the other important factors.

Recommendations for future research

Our work has identified the following priority research questions:

1. What is the pattern of health service utilisation in the last year of life and how is it related to where patients die?
2. How are clinical characteristics in the last year of life related to where patients die?
3. Is the distribution of end-of-life care facilities related to where patients die?

This report researched in detail the temporal and geographical patterns in PoD in several important causes of death, and found varied levels of inequality in PoD. However, with the cross-sectional death registry data we cannot know what happened before the final PoD, the transition of place of care and how these transitions related to PoD. We also believe it would be helpful to explore the distribution of end-of-life health-care facilities and its relationship with PoD.

We found a consistent inequality pattern in age, marital status and deprivation. The patients who died at older age (e.g. > 85 years); were single, divorced and widowed; and lived in deprived areas were more likely to die in hospital. The inequality in PoD is also evident in CoD, for example deaths from haematological and lung cancers were more likely to have occurred in hospitals.

We believe that enhanced community care and primary care facilities would be helpful in reducing the inequalities in PoD. Currently, our end-of-life health-care facilities are not optimised to enable people to die at their preferred place, which usually is at home or in a hospice. This research is important, as it can deepen our understanding of how we can make better use of existing resources to deliver quality care at the end of life; it can also help us to prioritise and plan for resource allocation.

There was a scarcity of UK data evaluating the relationship between end-of-life care patterns in the last year of life and PoD, although limited information on the topic is available from the USA, Canada and some Western European countries. We found two UK-based studies that assessed the service use in the last year of life and its relationship with PoD; however, both studies were conducted in specific settings (e.g. hospice) or subpopulations (e.g. aged > 75 years).

To the best of our knowledge, there are no data from wider end-of-life care settings or populations in the UK that address the proposed research questions. We believe that linked health-care data facilities can supply information to answer these important research questions and make improvements for end-of-life care policy.

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Contribution of authors

Dr Wei Gao (Senior Lecturer in Statistics and Epidemiology, KCL) Co-leader of the project and project manager; undertook the analysis, and wrote the first draft of the report.

Mr Yuen K Ho (Research Assistant, KCL) Managed and maintained the database, prepared and linked the data, produced the bivariate graphs and GIS graphs. Assisted and supervised by WG and IJH.

Dr Julia Verne [Director for Knowledge & Intelligence (South West) and Clinical Lead – National End of Life Care Intelligence Network] Contributed to all phases of the project, and provided critical comments on the draft of the report and interpretation of the data.

Dr Emma Gordon (Head of Life Events Analysis, ONS) Contributed to all phases of the project, and provided critical comments on the draft of the report and interpretation of the data.

Professor Irene J Higginson (Professor of Palliative Care, KCL) Co-leader of the project; provided senior support for project management and significantly contributed to writing the first draft of the report;

All authors approved the final version.

The investigators of the GUIDE_Care project: Irene J Higginson (Principal Investigator), Wei Gao, Julia Verne, Myer Glickman and Barbara Gomes.

The Members of the Project Advisory Group (PAG): Tony Bonser, Shaheen Khan, Jonathan Koffman, Katie Lindsey, Roberta Lovick, Tariq Malik, Julie Messer, Carolyn Morris, Andy Pring, Stafford Scholes and Katherine Sleeman.

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Patient and public involvement

Service users were involved through an existing group – the COMPASS Collaborative Consumer Group – with whom we have developed a close working relationship through other projects. Patients and service users have been involved in the project in the following ways: (1) provided lay feedback and comments; (2) monitored progress of the research as a member of the PAG; (3) helped to develop and implement dissemination plans; and (4) contributed/commented on reports/publications/findings establish links with wider (i.e. non-cancer) user groups.

Publications

Gao W, Ho YK, Verne J, Glickman M, Higginson IJ; project GUIDE_Care. Changing patterns in place of cancer death in England: a population-based study. *PLOS Med* 2013;**10**:e1001410. doi:10.1371/journal.pmed.1001410

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Appendix 1 Bivariate graphs by causes of deaths

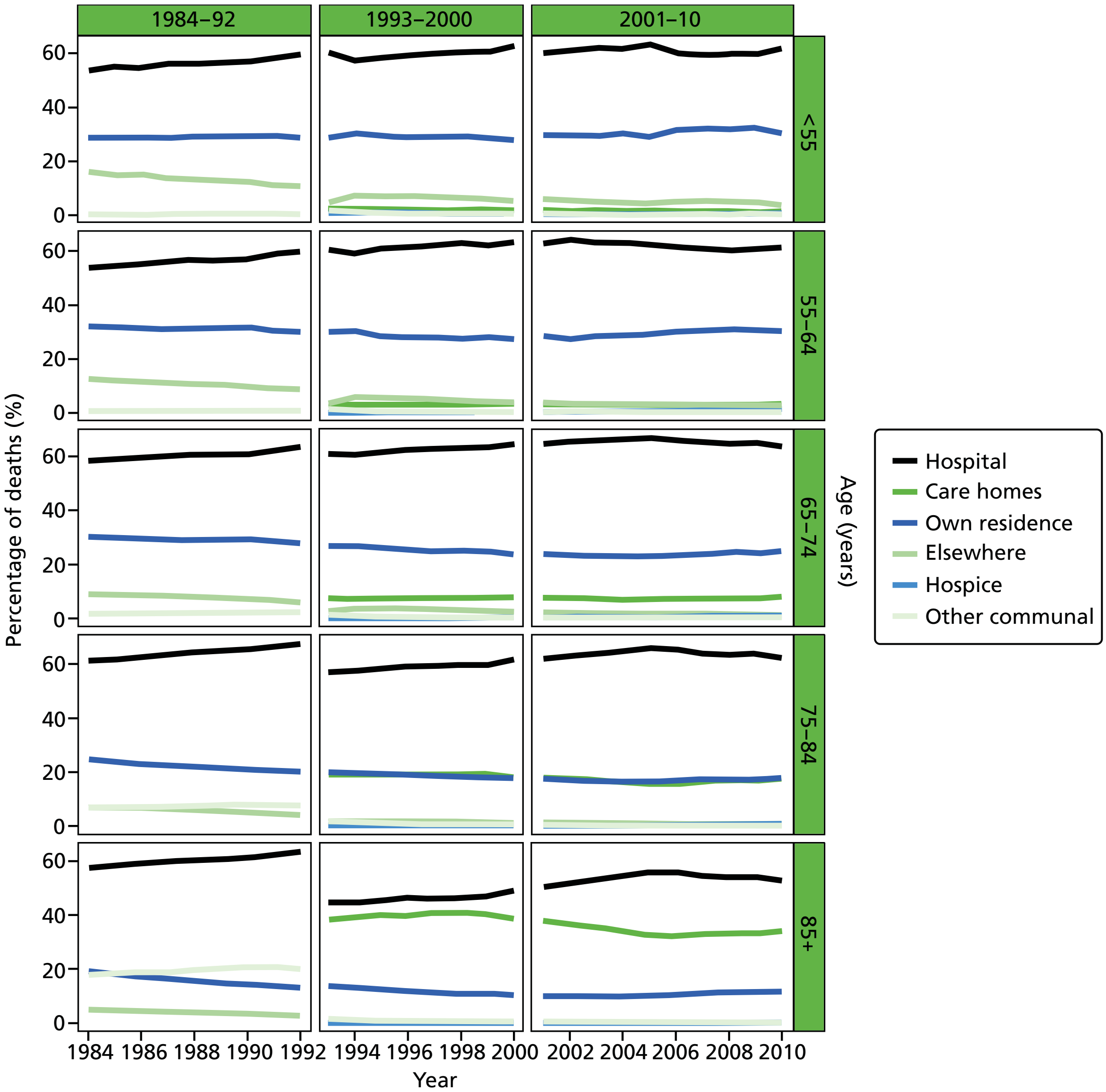

FIGURE 18 Place of death by age groups in all non-cancer deaths, England 1984–2010.

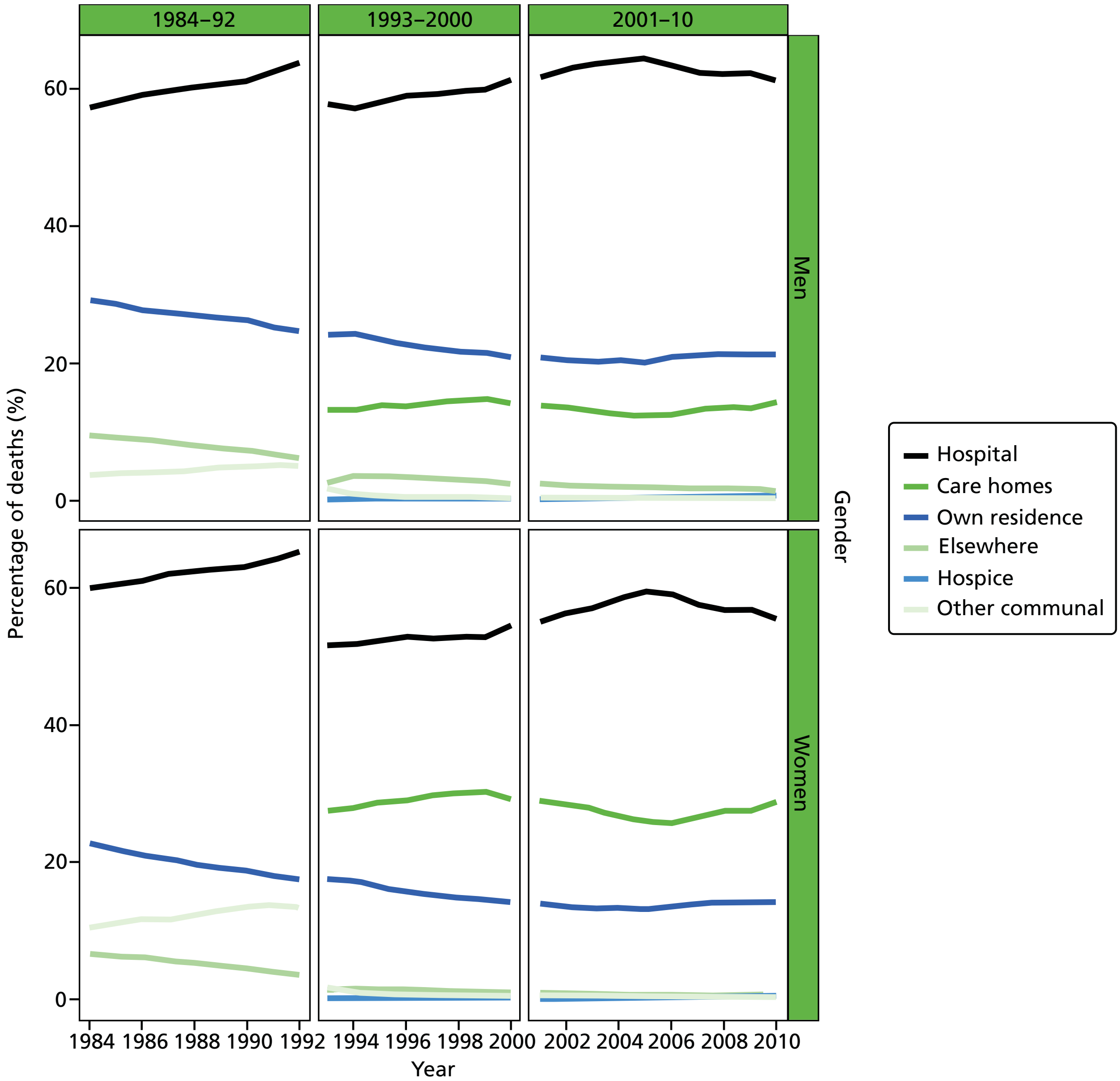

FIGURE 19 Place of death by gender in all non-cancer deaths, England 1984–2010.

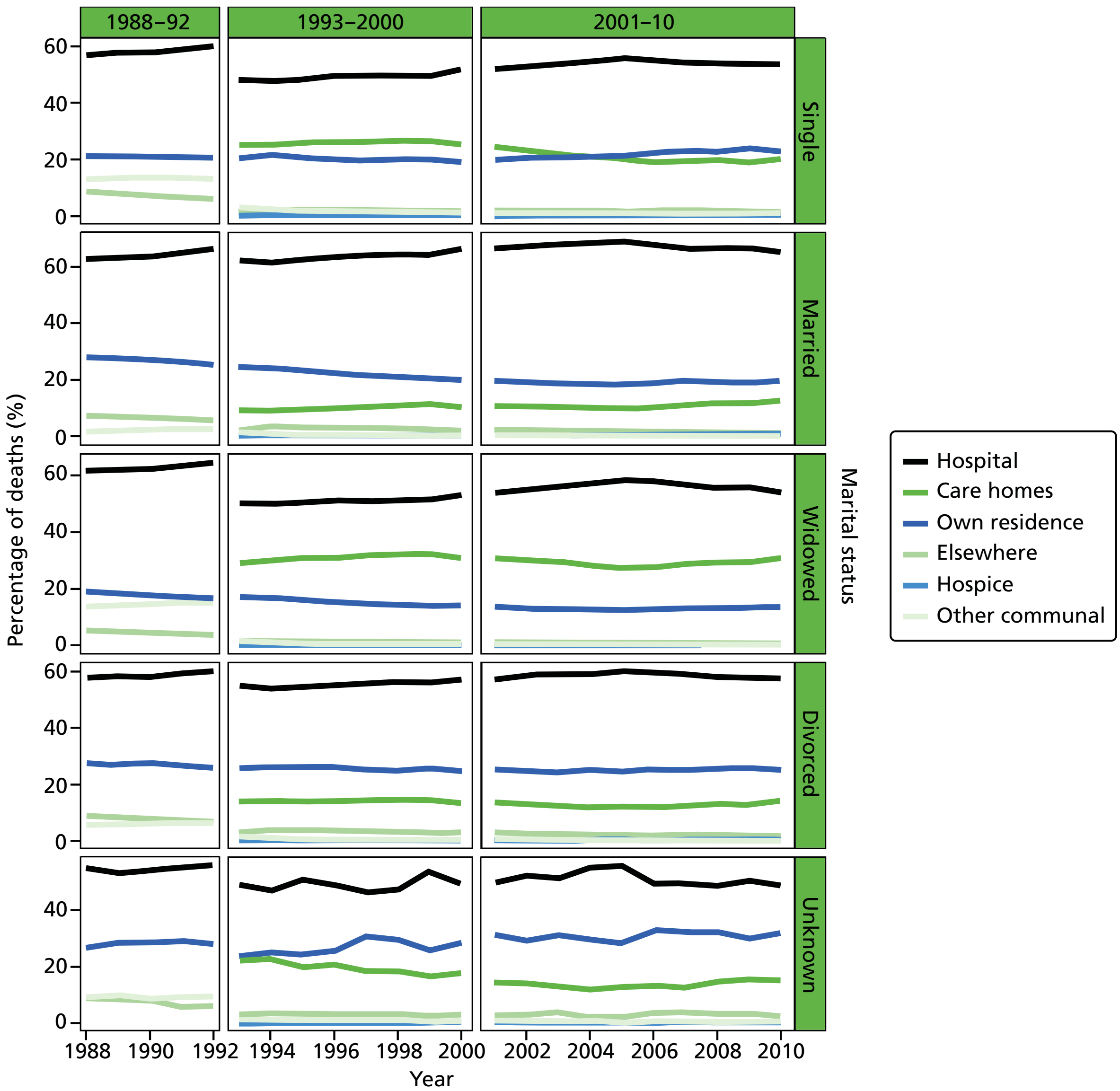

FIGURE 20 Place of death by marital status in all non-cancer deaths, England 1988–2010.

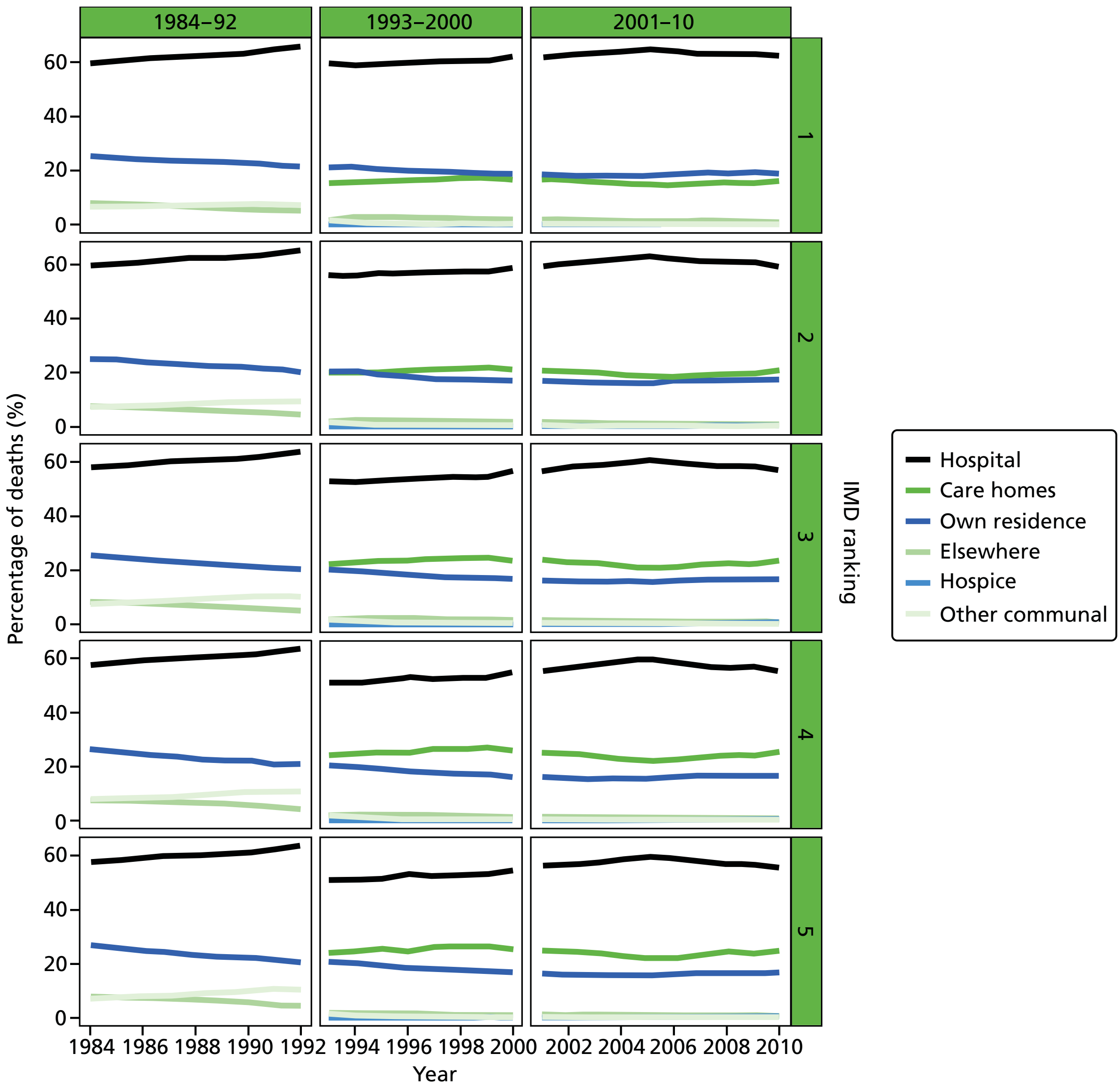

FIGURE 21 Place of death by IMD ranking (1 = most deprived, 5 = least deprived) in all non-cancer deaths, England 1984–2010.

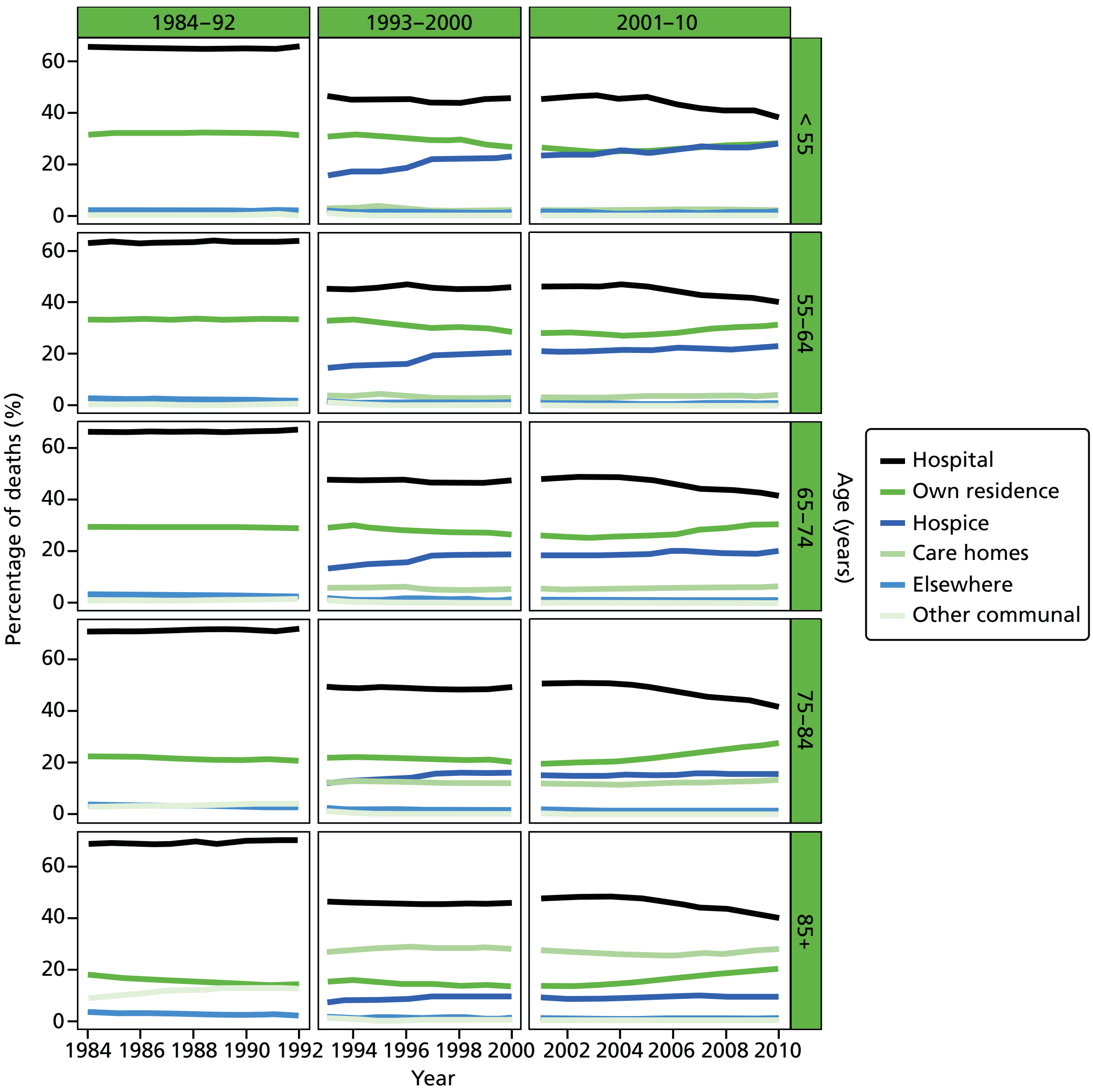

FIGURE 22 Place of death by age groups in cancer deaths, England 1984–2010.

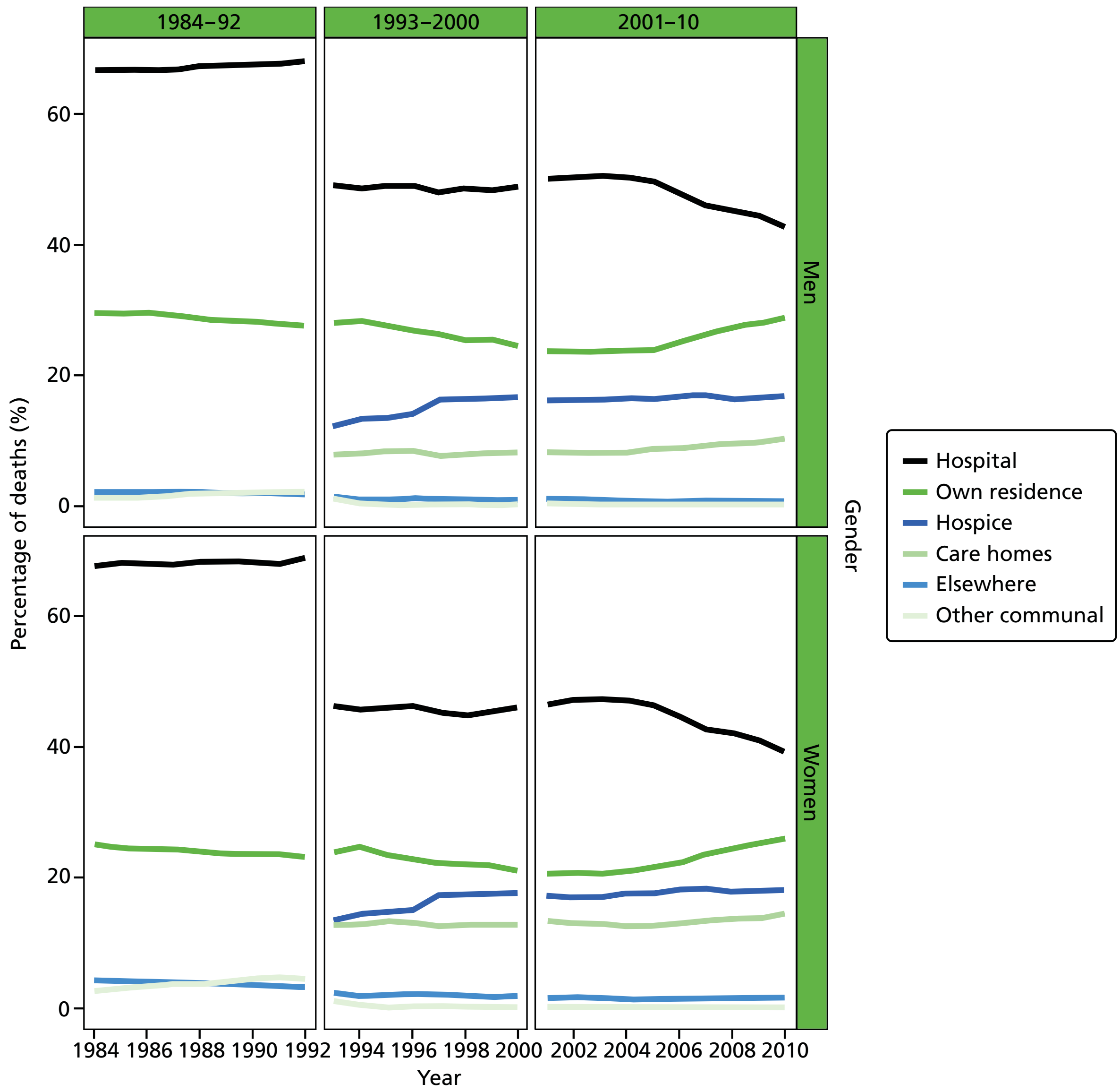

FIGURE 23 Place of death by gender in cancer deaths, England 1984–2010.

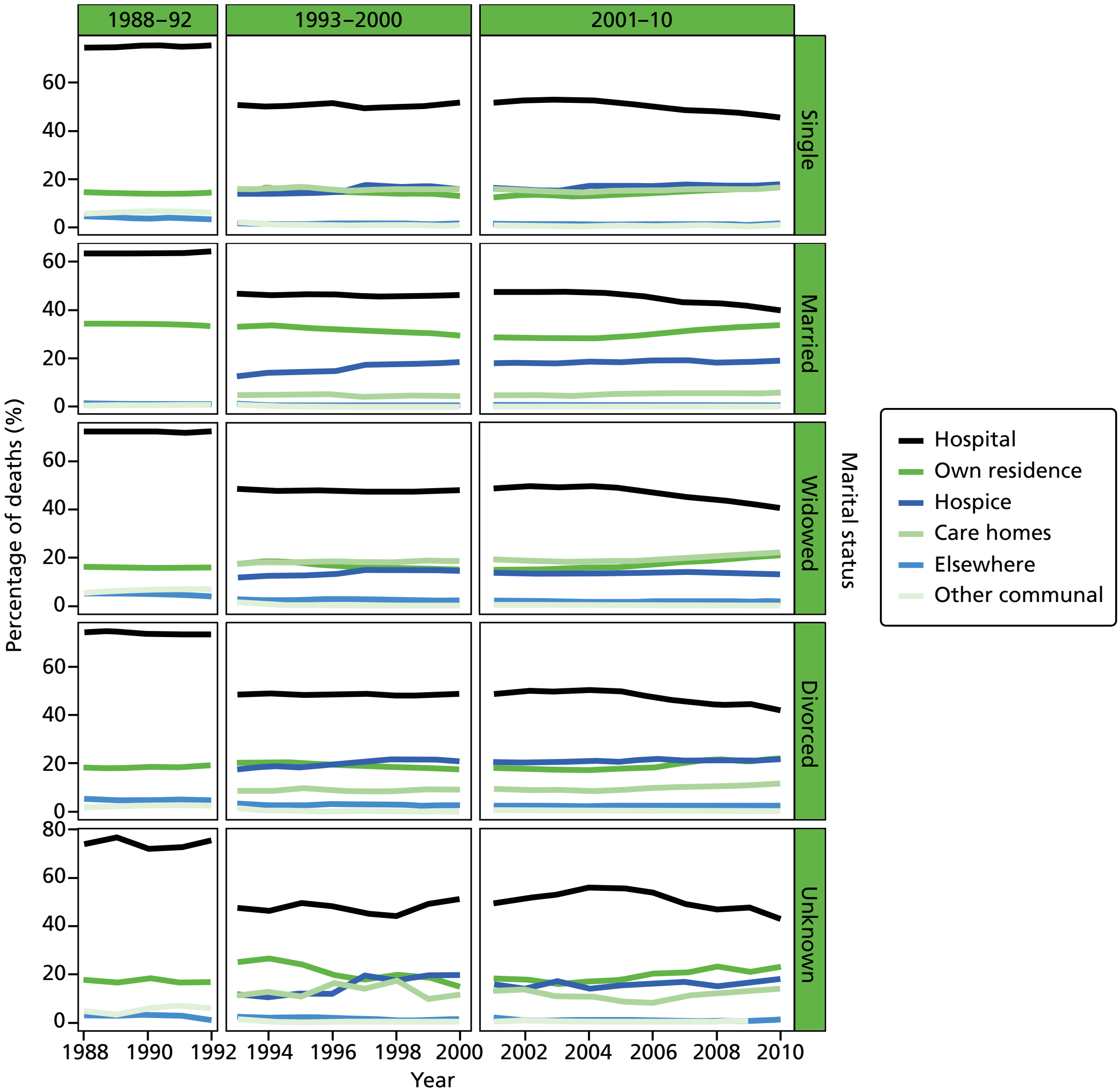

FIGURE 24 Place of death by marital status in cancer deaths, England 1988–2010.

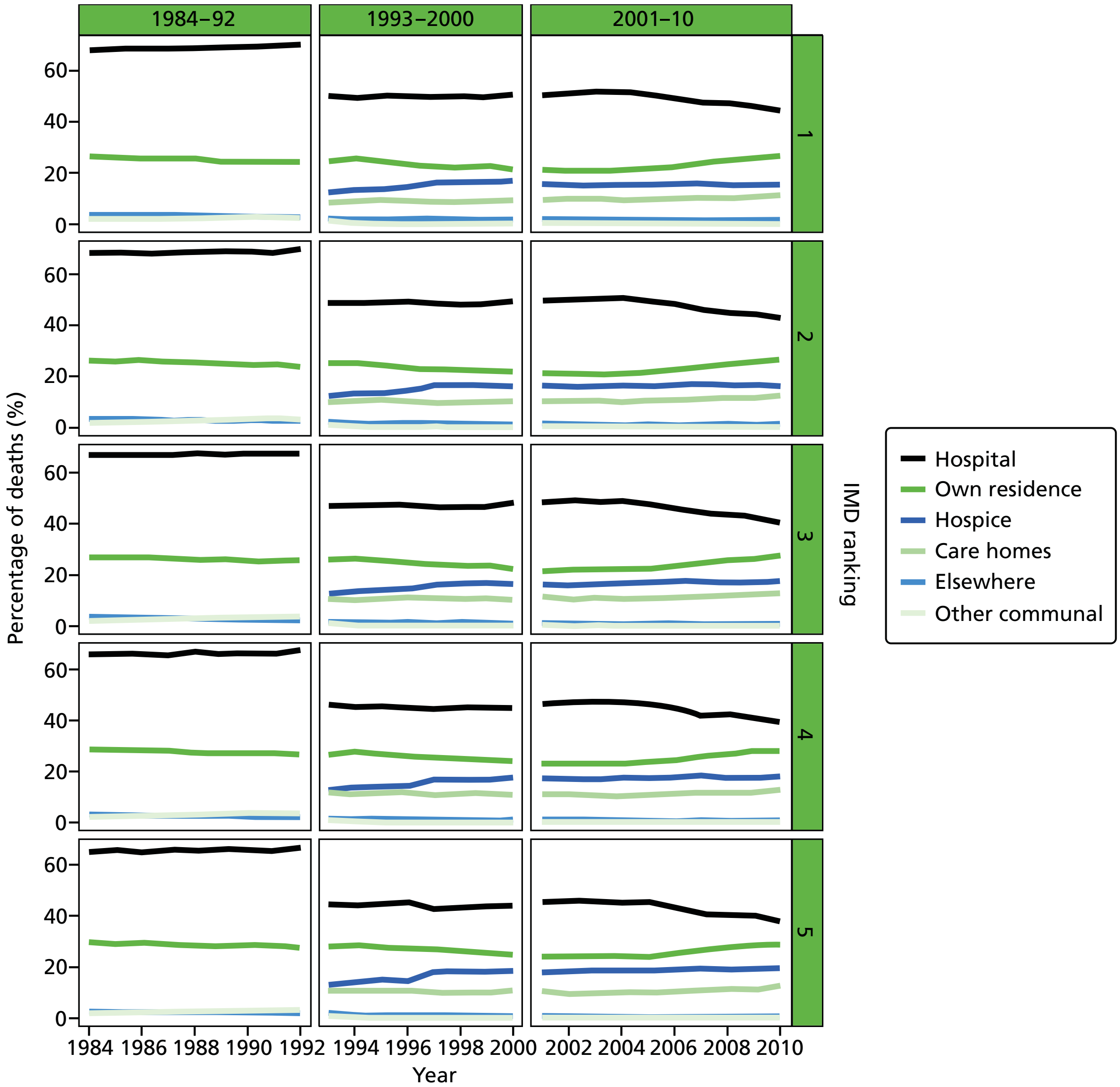

FIGURE 25 Place of death by IMD ranking (1 = most deprived, 5 = least deprived) in cancer deaths, England 1984–2010.

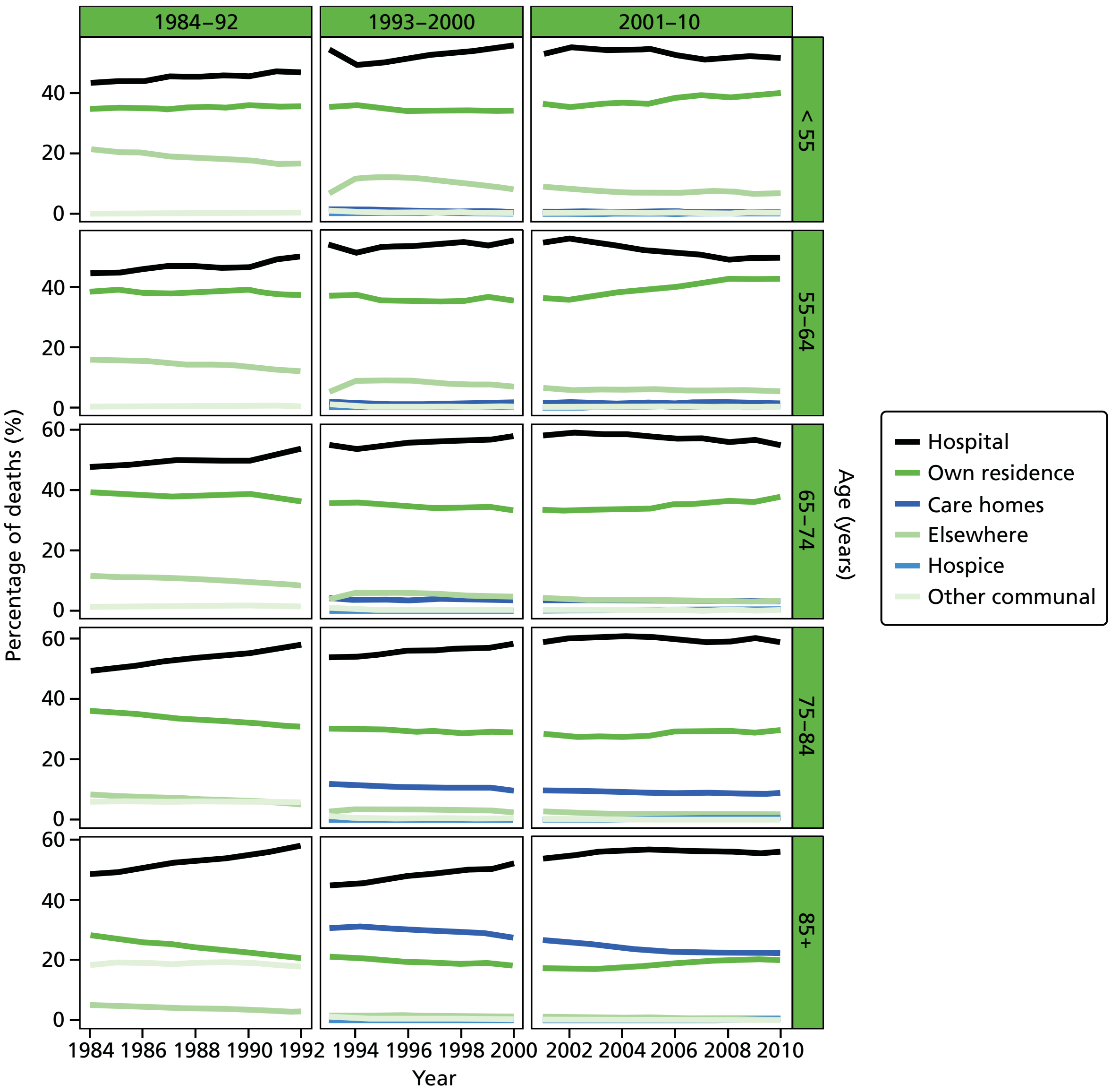

FIGURE 26 Place of death by age groups in deaths from CVDs, England 1984–2010.

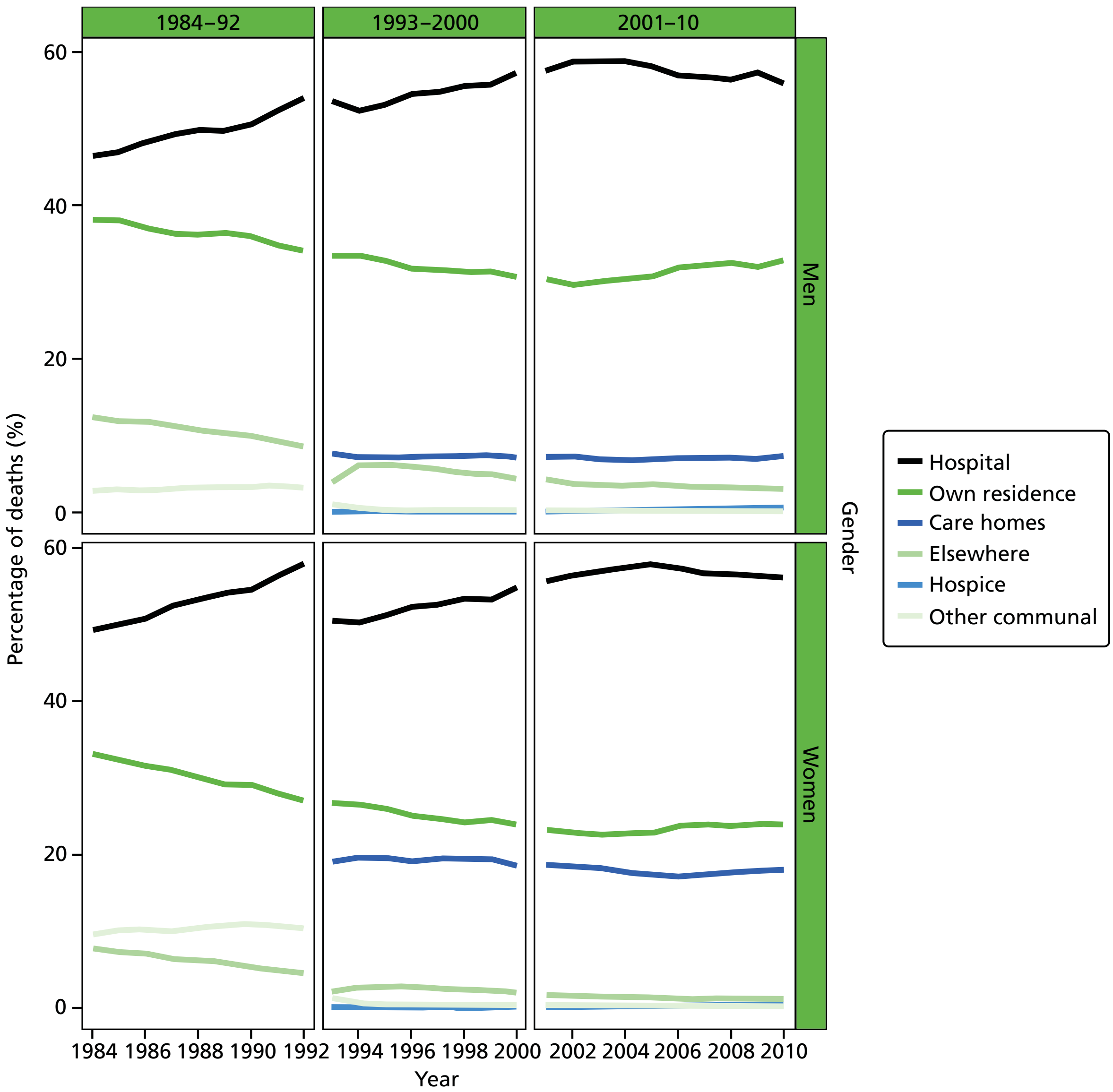

FIGURE 27 Place of death by gender in deaths from CVDs, England 1984–2010.

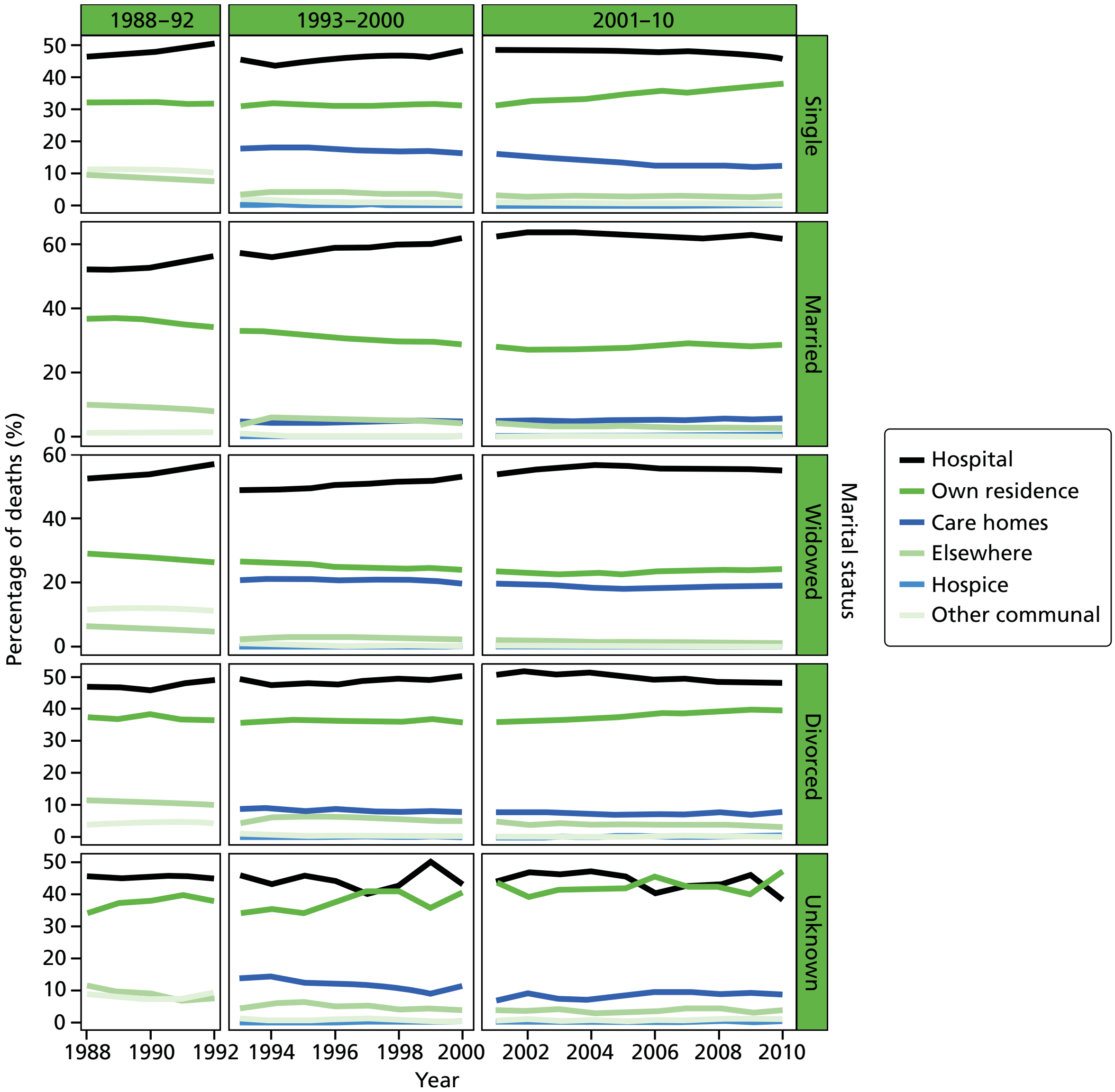

FIGURE 28 Place of death by marital status in deaths from CVDs, England 1988–2010.

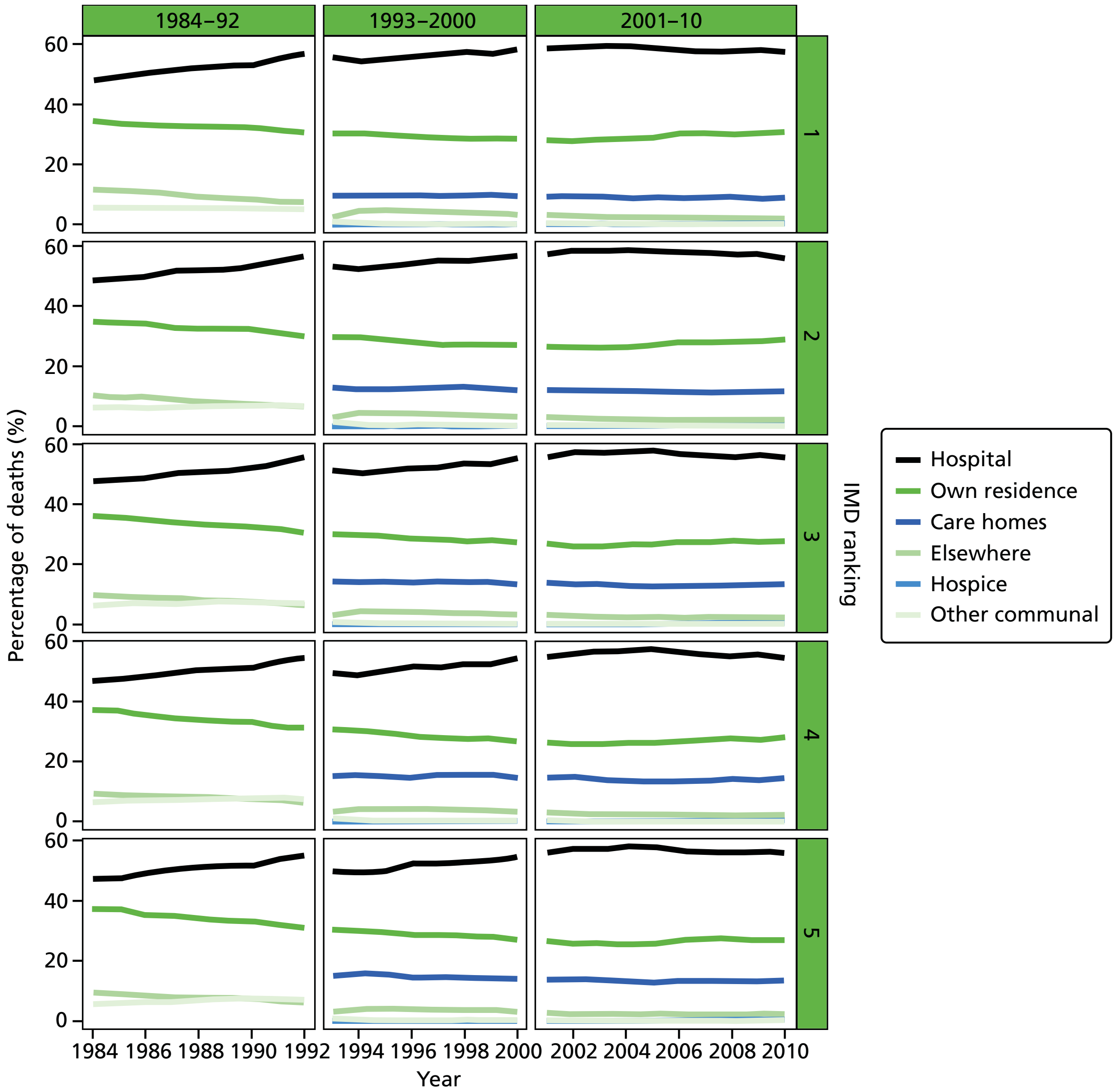

FIGURE 29 Place of death by IMD ranking (1 = most deprived, 5 = least deprived) in deaths from CVDs, England 1984–2010.

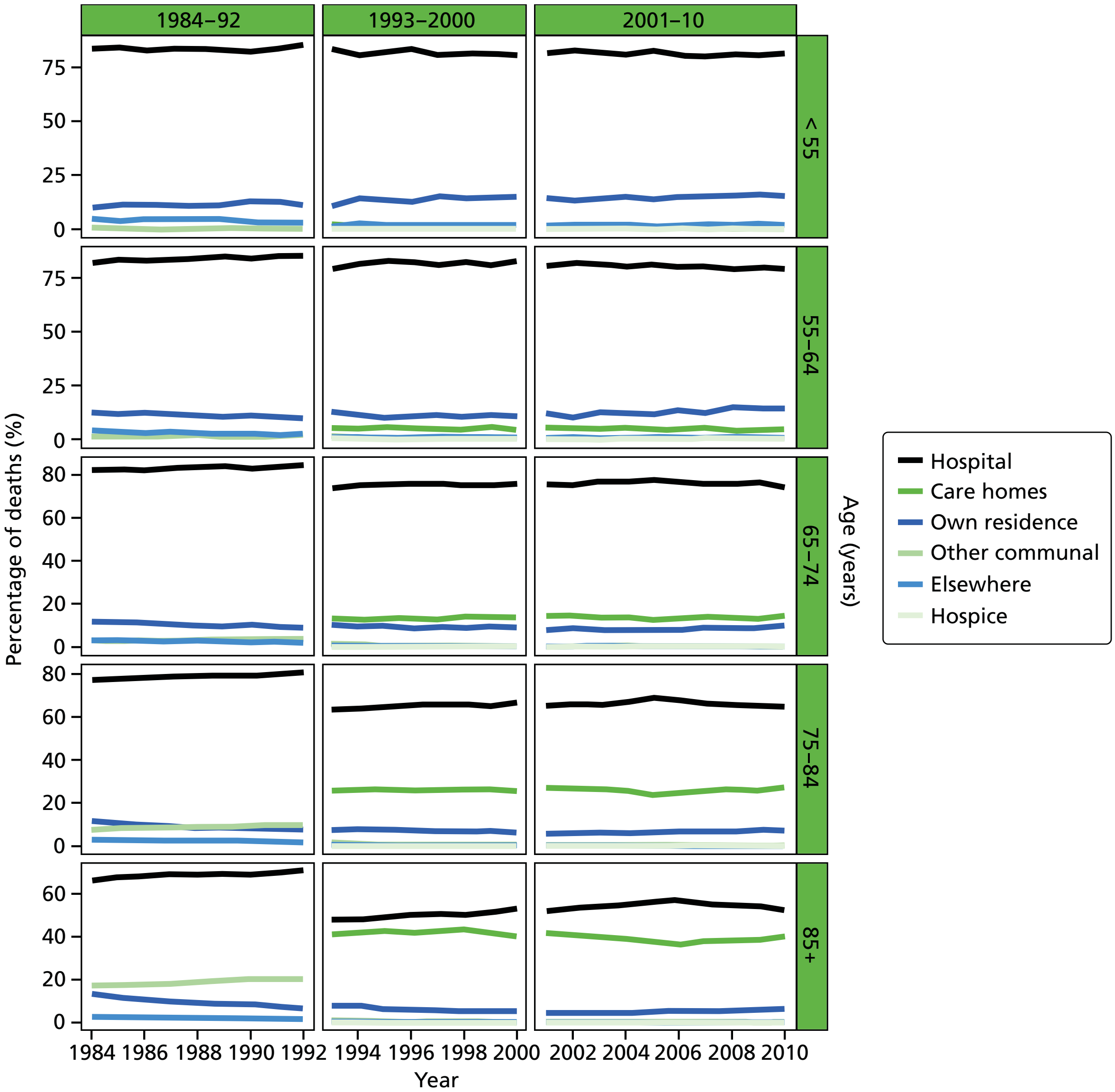

FIGURE 30 Place of death by age groups in deaths from CBDs, England 1984–2010.

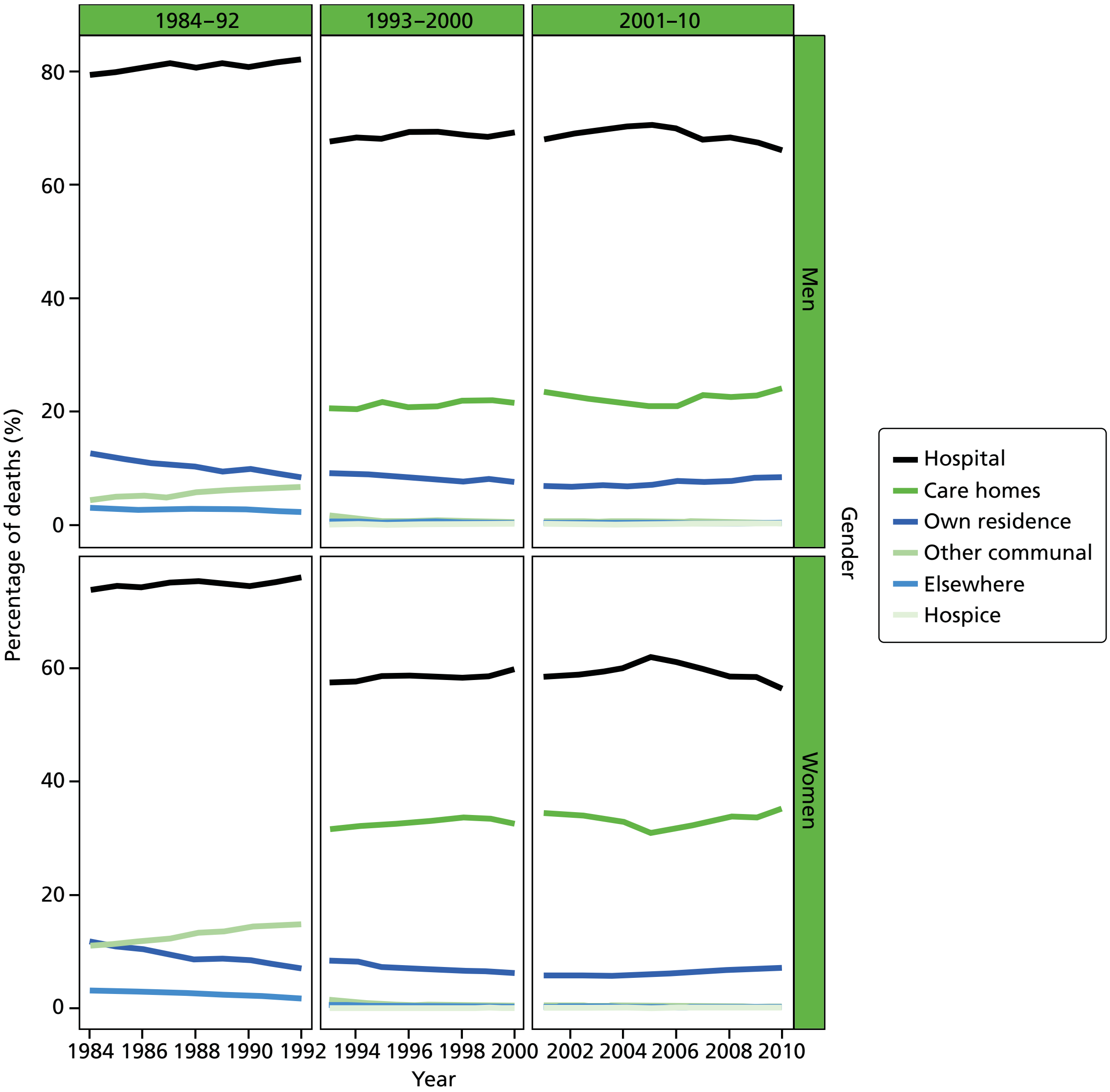

FIGURE 31 Place of death by gender in deaths from CBDs, England 1984–2010.

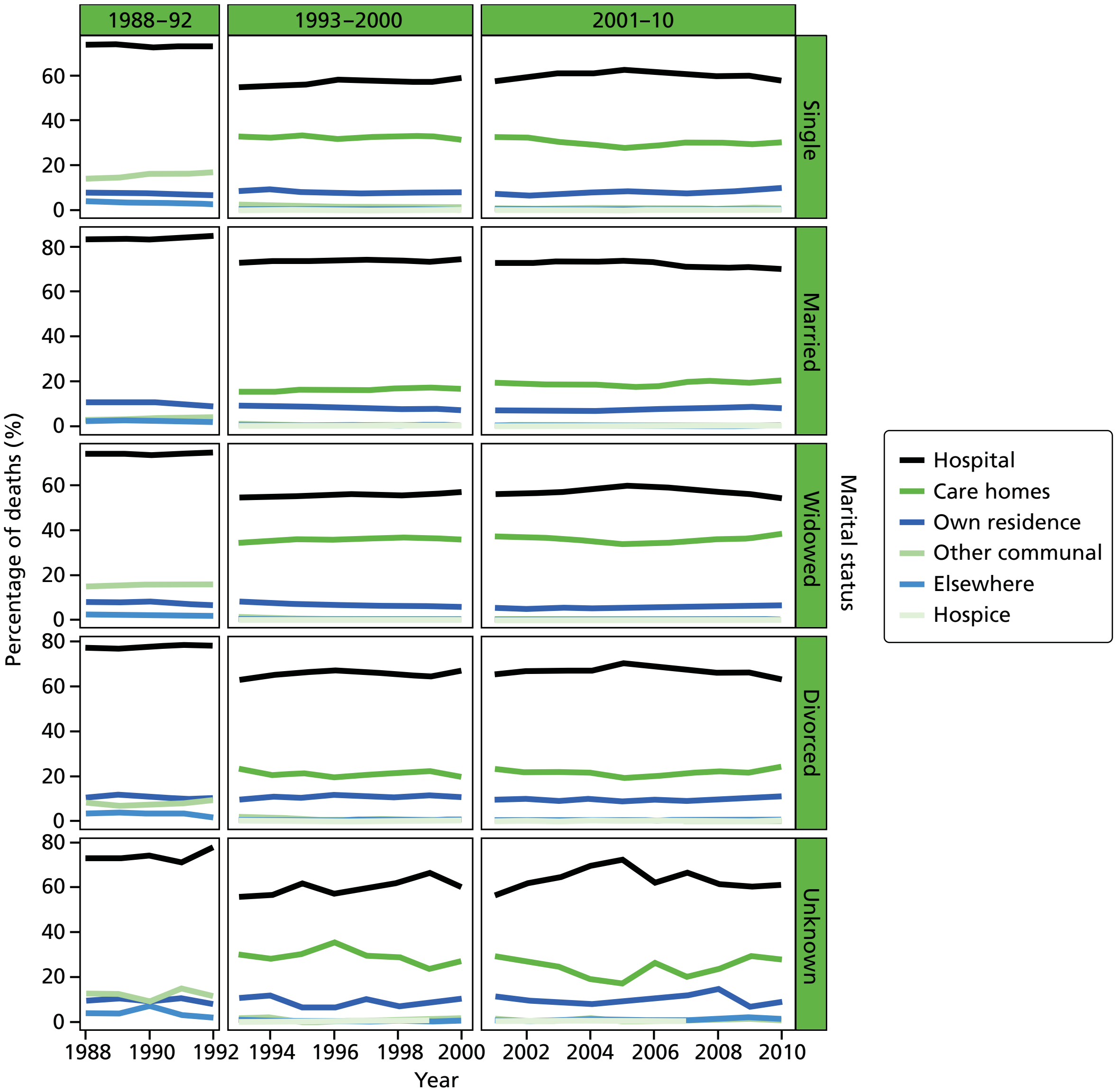

FIGURE 32 Place of death by marital status in deaths from CBDs, England 1988–2010.

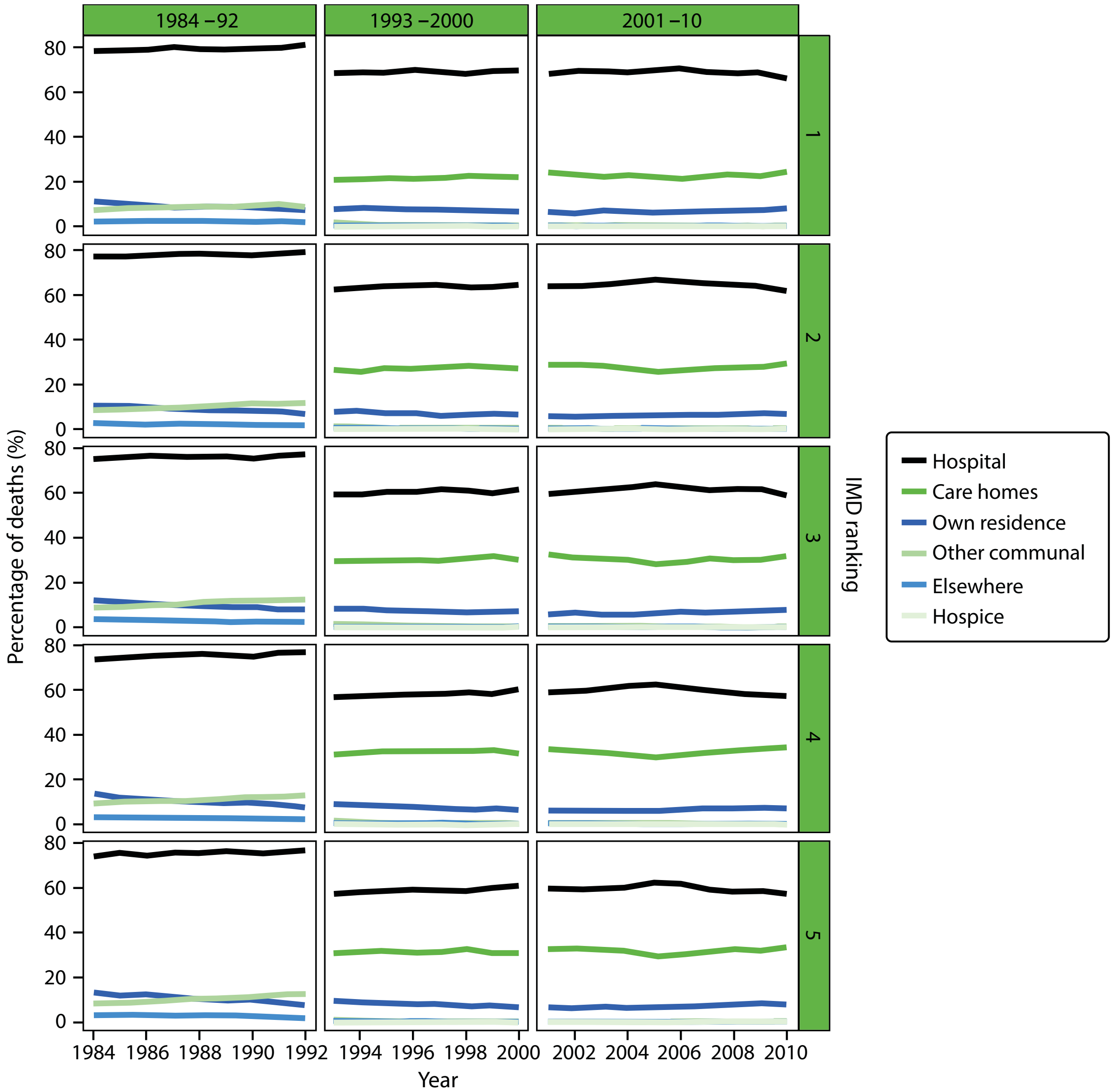

FIGURE 33 Place of death by IMD ranking (1 = most deprived, 5 = least deprived) in deaths from CBDs, England 1984–2010.

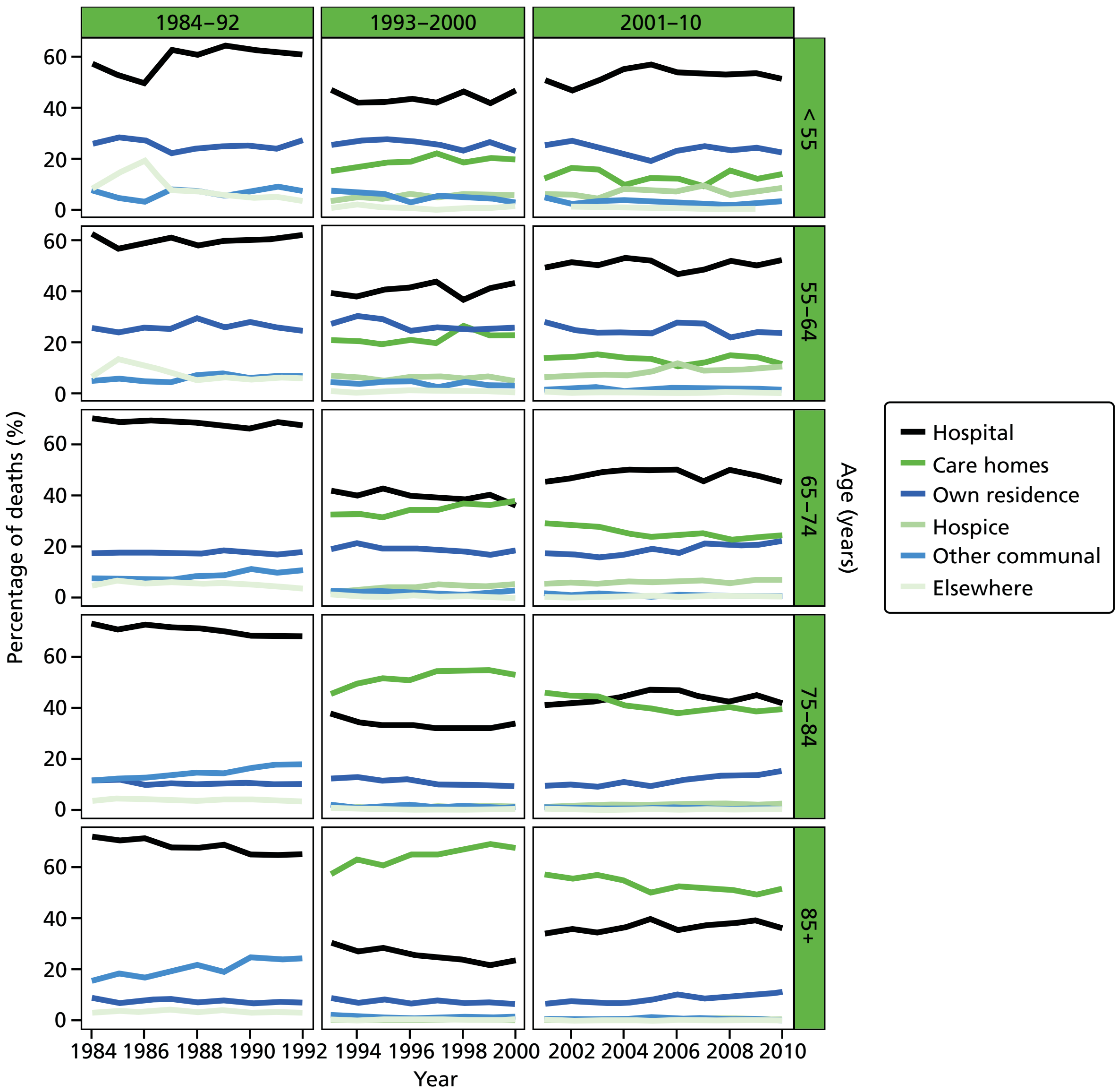

FIGURE 34 Place of death by age groups in deaths from neurological conditions, England 1984–2010.

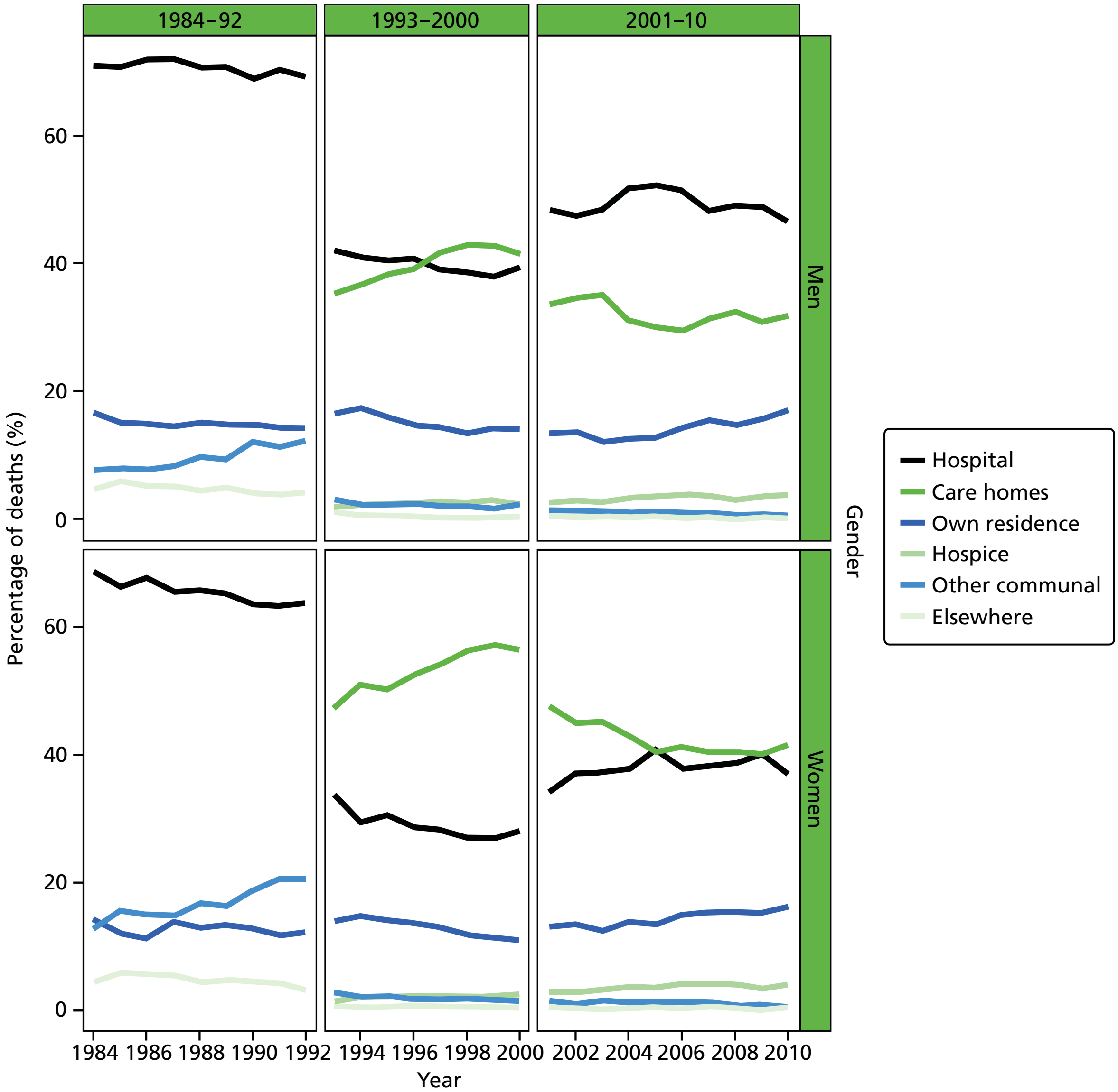

FIGURE 35 Place of death by gender in deaths from neurological conditions, England 1984–2010.

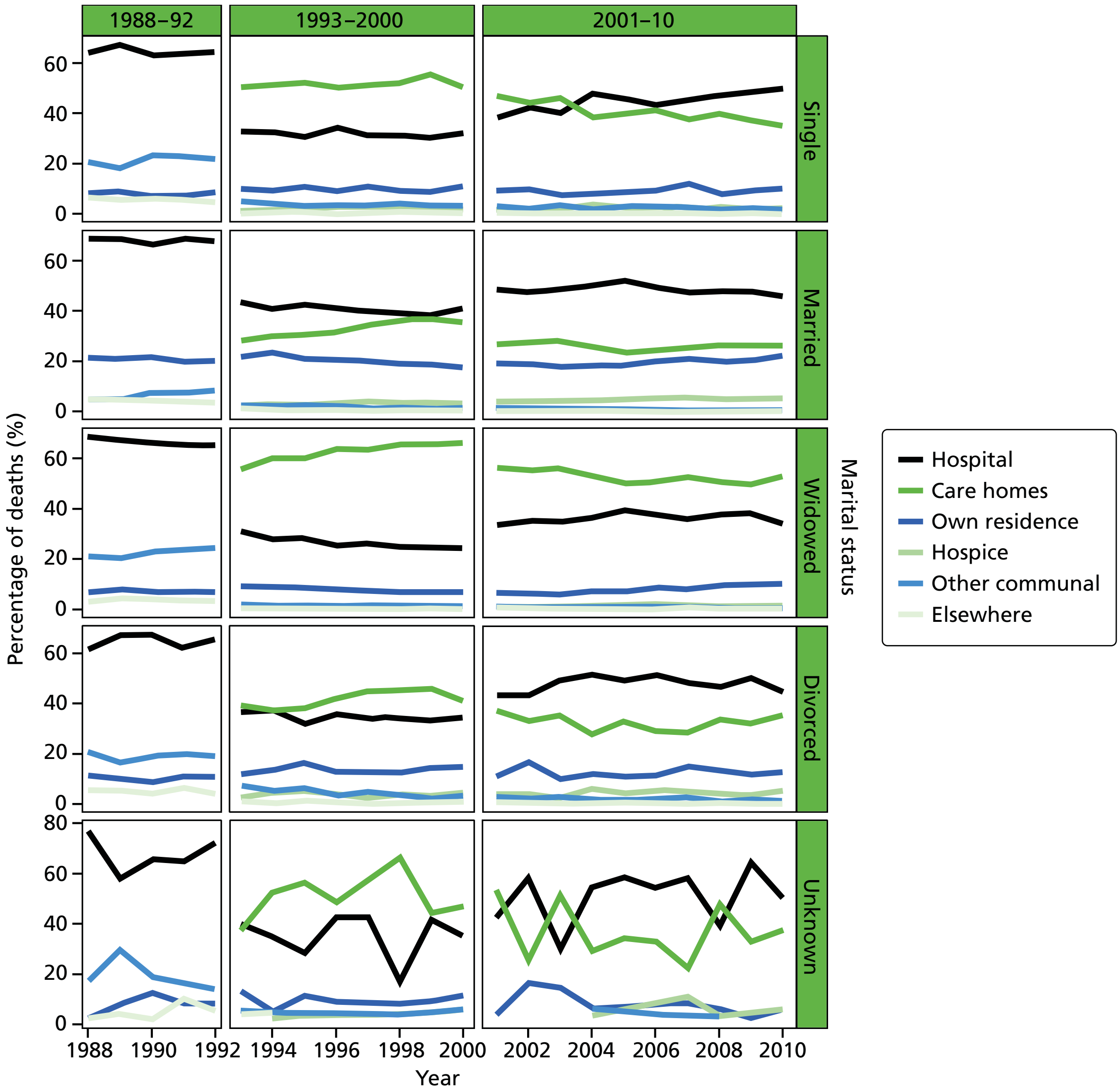

FIGURE 36 Place of death by marital status in deaths from neurological conditions, England 1988–2010.

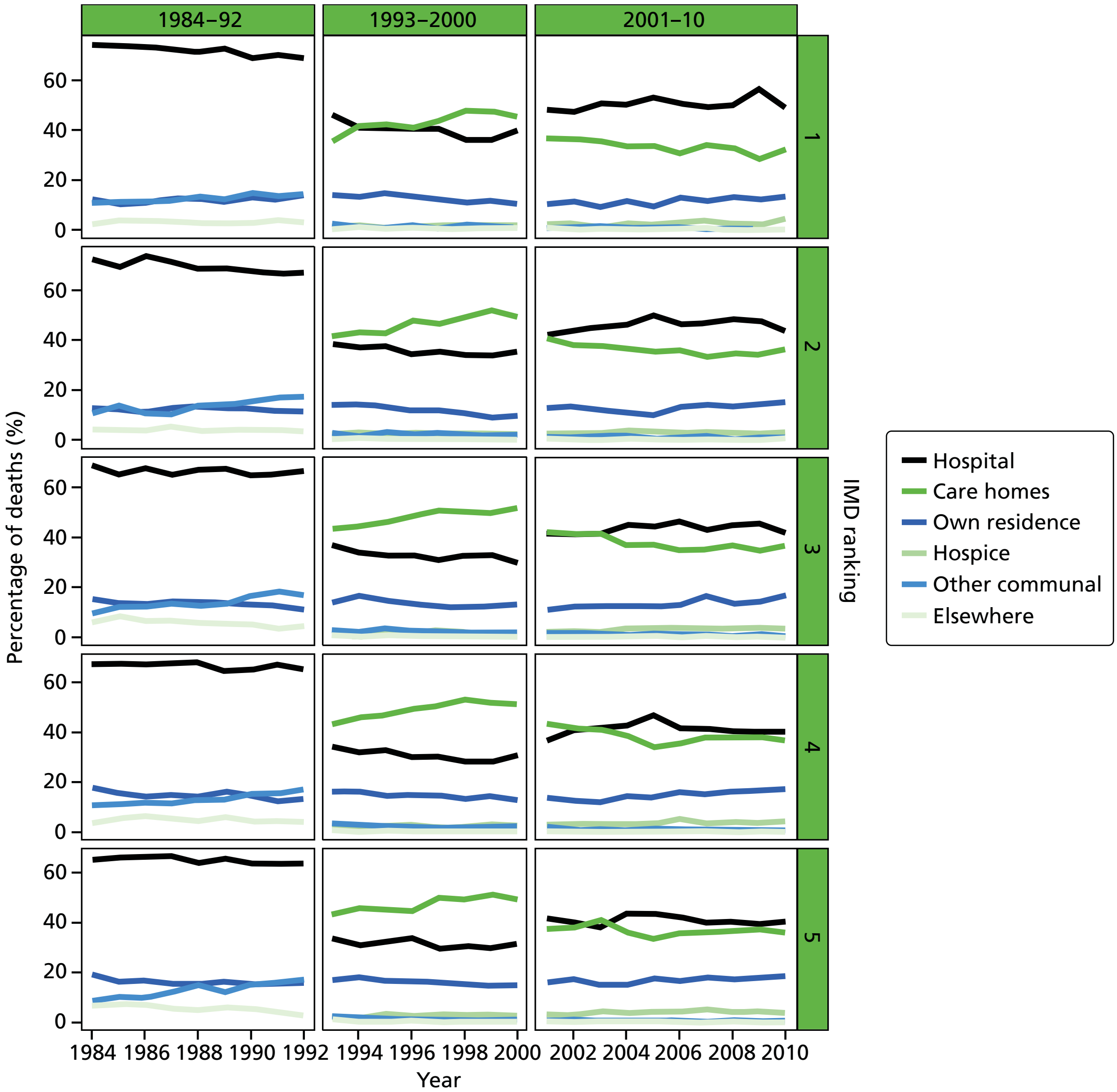

FIGURE 37 Place of death by IMD ranking (1 = most deprived, 5 = least deprived) in deaths from neurological conditions, England 1984–2010.

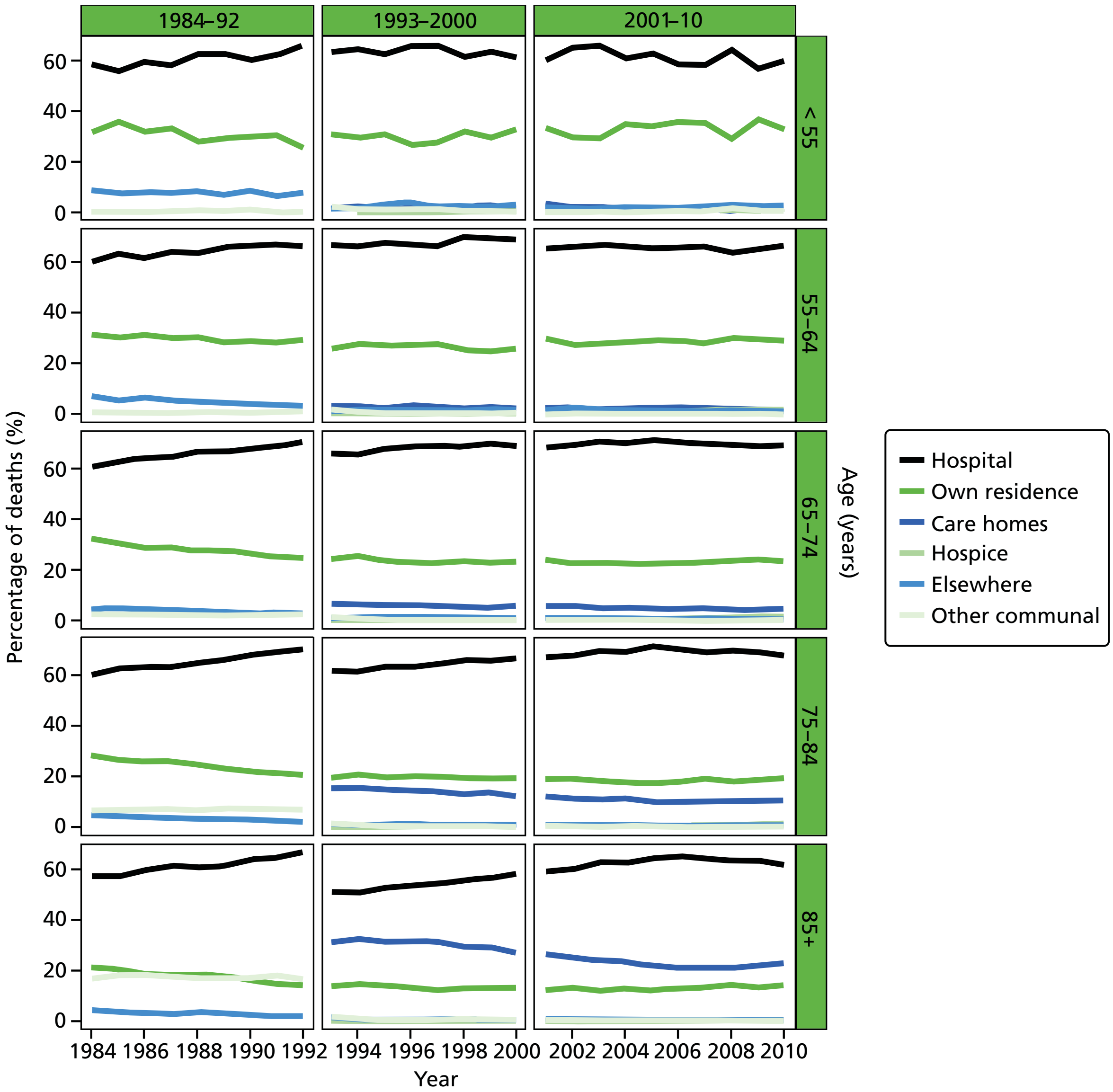

FIGURE 38 Place of death by age groups in COPD deaths, England 1984–2010.

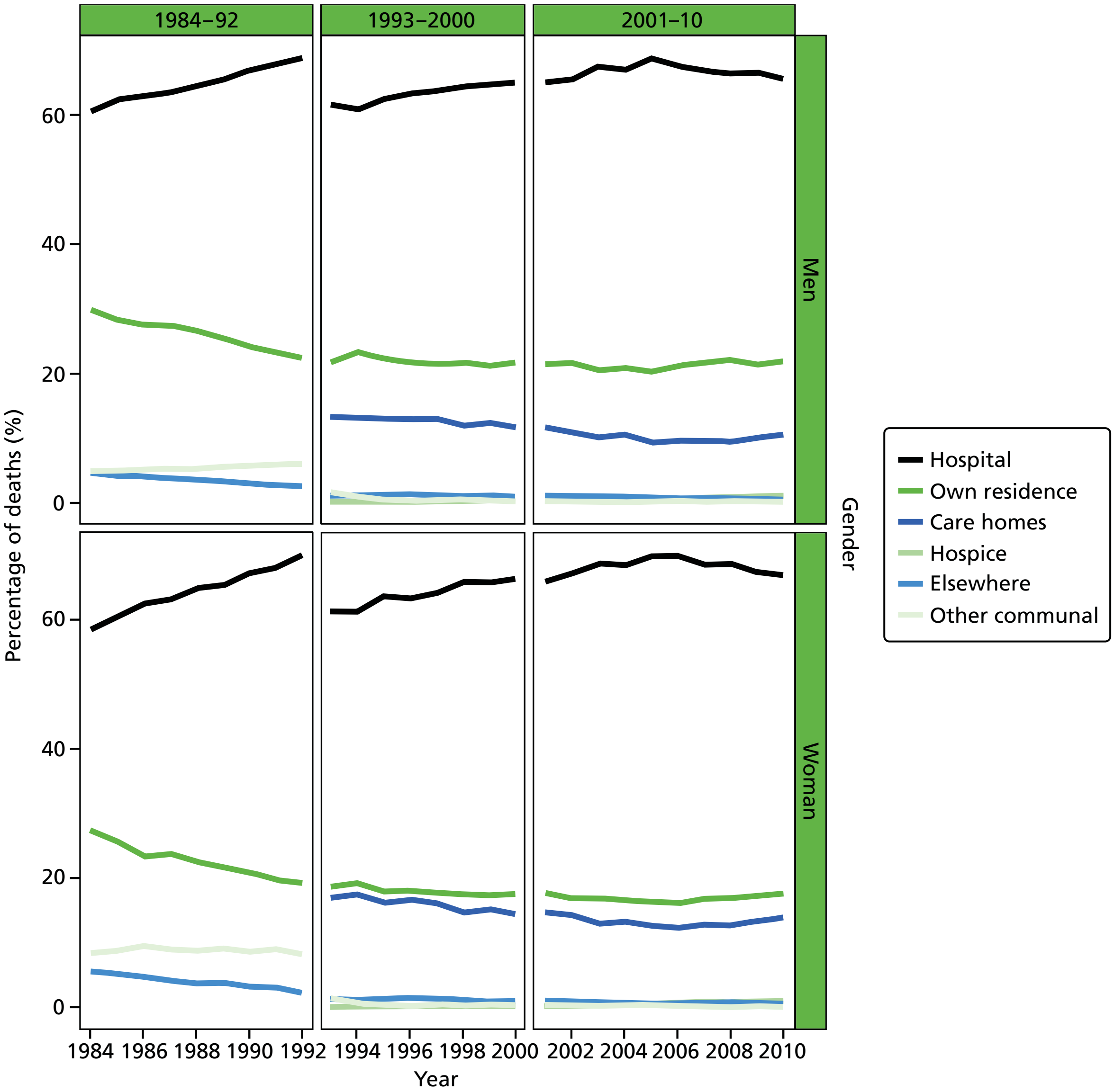

FIGURE 39 Place of death by gender in COPD deaths, England 1984–2010.

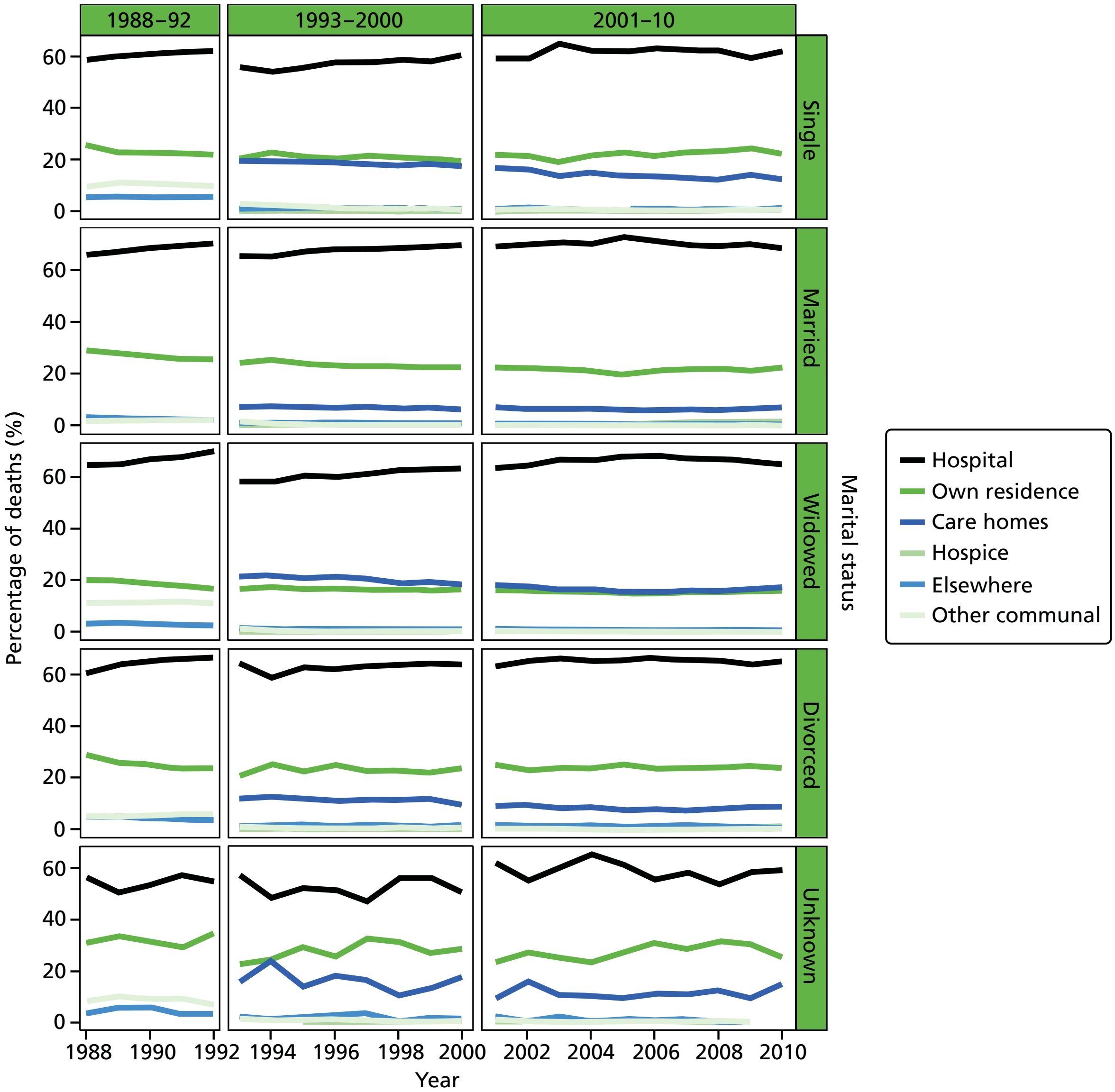

FIGURE 40 Place of death by marital status in COPD deaths, England 1988–2010.

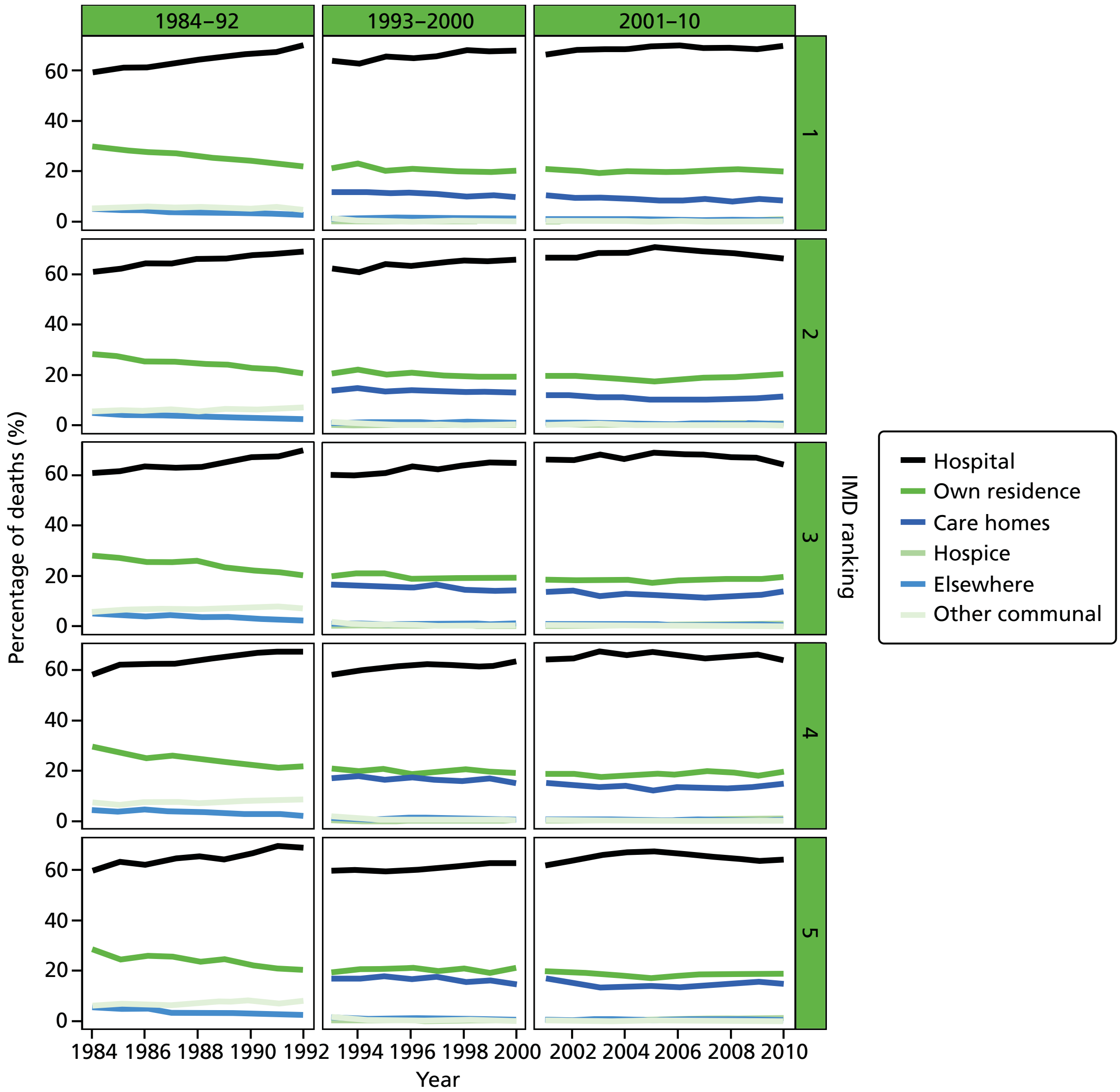

FIGURE 41 Place of death by IMD ranking (1 = most deprived, 5 = least deprived) in COPD deaths, England 1984–2010.

Appendix 2 List of research outputs

Peer-reviewed journal articles

Gao W, Ho YK, Verne J, Glickman M, Higginson IJ. Changing patterns in place of cancer death in England: a population-based study. *PLOS Med* 2013;**10**:e1001410. doi: 10.1371/journal

Sleeman KE, Ho YK, Verne J, Glickman M, Silber E, Gao W, *et al.*, on behalf of the GUIDE_Care Project. Place of death, and its relation with underlying cause of death, in Parkinson's disease, motor neurone disease, and multiple sclerosis: a population-based study. *Palliat Med* 2013;**27**:840–6.

Sleeman KE, Ho YK, Verne J, Gao W, Higginson IJ, on behalf of the GUIDE_Care project. Reversal of English trend towards hospital death in dementia. A population-based study of place of death and associated individual and regional factors, 2001–2010. *BMC Neurol* 2014;**14**:59.

Koffman J, Ho YK, Davies JM, Gao W, Higginson IJ. Does ethnicity affect where people with cancer die? A population based 10 year study. *PLOS One* 2014;**9**:e95052. doi:10.1371/journal.pone.0095052

Evans CJ, Ho YK, Daveson BA, Hall S, Higginson IJ, and Gao W on behalf of the GUIDE_Care project. Hidden needs of centenarians dying in care homes: a population-based observational study in England. *PLOS Med* 2014;**3**:11. doi:10.1371/journal.pmed

Conference abstracts and presentations

Sleeman KE, Davies JM, Ho YK, Verne J, Gao W, Higginson IJ. The changing demographics of inpatient hospice deaths. Population based study in England 1993–2010. European Association for Palliative Care, Lleida, Spain, 4–7 June 2014.

Sleeman KE, Ho YK, Verne J, Gao W, Higginson IJ. Reversal of English trend towards hospital death in dementia: a population-based study of place of death and associated individual and regional factors, 2001–2010. European Association for Palliative Care, Lleida, Spain, 4–7 June 2014.

Koffma, J, Ho YK, Davies JM, Gao W. Higginson IJ. Does ethnicity affect where people with cancer die? A population-based 10 year study. HERON Conference, London, 14 May 2014.

Gao W, Verne J, Glickman M, Higginson IJ. Place of death is associated with holiday periods: implication for end of life care. 13th World Congress of the European Association for Palliative Care, Prague, CZ, 30 May 2013. URL: www.congressinfo.org/filerun/weblinks/?id=e94550c93cd70fe748e6982b3439ad3b&filename=EAPC-Abstract-Book_FINAL%20Version_small.pdf (accessed 27 October 2014).

Evans CJ, Ho YK, Daveson B, Hall S, Higginson IJH, Gao W. 'Prolonged dwindling'; an over simplification of dying for centenarians? 13th World Congress of the European Association for Palliative Care, Prague, CZ, 30 May 2013. URL: www.congressinfo.org/filerun/weblinks/?id=e94550c93cd70fe748e6982b3439ad3b&filename=EAPC-Abstract-Book_FINAL%20Version_small.pdf (accessed 27 October 2014).

Gao W. Changing patterns in place of cancer deaths in England, 2001–2010: Time trends and associated factors. Society for Social Medicine 56th Annual Scientific Meeting, London, UK, 12 September 2012.

Gao W, Ho YK, Verne J, Glickman M, Higginson IJ. Place of cancer deaths in England, 2001–2010: Time trends and determinants. Society for Social Medicine 56th Annual Scientific Meeting; 2012 Sep 12; London, UK. *J Epidemiol Community Health* 2012;**66**(Suppl. I):A27.

Ho YK, Gao W, Verne J, Glickman M, Higginson IJ. Where do cancer patients die? An 18-year trend in England. 2012 NCRI Cancer Conference; Liverpool, UK, 5 November 2012. URL: http://conference.ncri.org.uk/abstracts/2012/abstracts/A170.html (accessed 27 October 2014).

Gao W, Ho YK, Verne J, Glickman M, Higginson IJ. Place of death in tuberculosis: an analysis from Death Registry in England, 2001–2010. 6th Conference of the Union Europe Region: International Union Against Tuberculosis and Lung, London, UK, 4 July 2012.

Sleeman K, Ho YK, Verne J, Gao W, Higginson IJ. Sociodemographic determinants of place of death in dementia: whole population cross-sectional analysis in England, 2001–10. Spring Meeting for Clinician Scientists in Training, 2013 Feb 27; London, UK. *Lancet* 2012;**381**:S101.

Sleeman K, Ho YK, Verne J, Gao W, Higginson IJ. Where do people with dementia die? Population-based study of ten year trends, and associated individual and regional factors. Spring Meeting for Clinician Scientists in Training, London, UK, 27 February 2013.

Sleeman K, Ho YK, Verne J, Glickman M, Silber E, Gao W, *et al.* Trends in place of death, and the effect of death certificate classification and coding changes, in Parkinson's disease, motor neurone disease, and multiple sclerosis in England: 1993–2010. *J Neurol Neurosurg Psychiatry* 2012;**83**(Suppl. 2):A17.

Sleeman K, Ho YK, Verne J, Glickman M, Silber E, Gao W, *et al.* Trends in place of death and death certificate coding for Parkinson's disease, motor neurone disease and multiple sclerosis in England 1993–2010. Poster session presented at King's College London, London, UK, 10 May 12.

Sleeman K, Ho YK, Verne J, Glickman M, Silber E, Gao W, *et al.* Place of death and death certificate coding for Parkinson's disease, motor neurone disease and multiple sclerosis in England 1993–2010. Poster session presented at conference of the Association of British Neurologists, Brighton, UK, 29 May 2012.

Press releases

National Institute for Health Research & EurekAlert. *Hospital Remains Most Common Place of Death for Cancer Patients in England*. 2013. URL: www.netscc.ac.uk/hsdr/news27032013.html, www.eurekalert.org/pub_releases/2013-03/plos-hrm032613.php (accessed 21 October 2014).

Cicely Saunders Institute. *Home and Hospice Deaths Increasing Since the Launch of National Programme*. 2013. URL: www.csi.kcl.ac.uk/home-and-hospice-deaths-increasing-since-the-launch-of-national-programme.html (accessed 21 October 2014).

BBC News, Health. *Centenarians 'Outliving Diseases of Old Age'*. 2014. URL: www.bbc.co.uk/news/health-27682376 (accessed 18 September 2014).

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