ORIGINAL RESEARCH

Socioeconomic Disparity Trends in End-of-Life Care for Cancer and Non-Cancer Patients: Are We Closing the Gap?

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Purpose: Socioeconomic disparities in end-of-life care have been reported across underlying diseases, but there is a paucity of information on potential time trends. Thus, we aimed to examine time trends in use of health-care services at the end of life according to socioeconomic position in patients dying from cancer and non-cancer diseases.

Materials and Methods: We conducted a nationwide registry-based study among adults dying from cancer or non-cancer diseases (diabetes, dementia, heart failure, ischemic heart disease, stroke, chronic liver disease, and chronic obstructive pulmonary disease) in Denmark in 2006–2016. We obtained data on patients' educational level and income level and use of health-care services within three months before death. Use of health-care services according to educational level and income level was plotted by calendar year of death and compared by regression analyses adjusting for age, sex, comorbidity, cohabitation, and municipality.

Results: In both cancer (n = 169,694) and non-cancer patients (n = 180,350), we found limited socioeconomic disparities and no clear temporal trends in use of hospital, intensive care, emergency room, general practice, home care nurse, and hospice. In 2006/2007, one percentage point more cancer patients with high income level compared with low income level were affiliated with hospital-based specialist palliative care (adjusted mean difference: 0.01 (95% confidence interval (CI): 0.01; 0.02)), whereas this was 12 percentage points in 2016 (adjusted mean difference: 0.12 (95% CI: 0.09; 0.14)).

Conclusion: Socioeconomic disparities in specialist palliative care tended to increase over time among cancer patients but were limited and without clear time trends in use of other health-care services in both cancer and non-cancer patients.

Keywords: chronic disease, death, hospitals, neoplasms, palliative care, socioeconomic factors

Introduction

Supporting equity in health by ensuring equal opportunities to access healthcare for those in equal need is a key health policy priority in universal tax-financed health-care systems.[1] However, socioeconomic disparities in health status and access to healthcare have been reported across a range of medical conditions.[2–6]

The end of life represents a period of particular high healthcare use,[7,8] and it remains challenging to provide the most appropriate care for terminally ill patients.[9] A number of studies, including a systematic review, have found socio-economic disparities in end-of-life care.[10–13] Hence, low socioeconomic position has been reported to be associated with inferior end-of-life care, including not receiving specialist palliative care in the terminal phase as well as being acutely admitted to hospital and dying there.[10–13] However, the evidence base is dominated by studies reaching back decades. Though a few previous studies suggested socioeconomic disparity trends, particularly regarding place of death,[14–16] there is a paucity of information on possible temporal trends in disparities in end-of-life care including various health-care

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services. Furthermore, socioeconomic disparities may potentially be on the rise due to population ageing, which translates into higher proportions of patients dying from chronic diseases and thereby further increasing the demands for palliative care services.[17,18] Thus, it remains unclear whether increasing health policy attention towards reducing socioeconomic disparities in health has reduced the disparity gap in end-of-life care.[1] In addition, it is uncertain to what extent the socioeconomic disparities are linked with the underlying disease, as it is well known that palliative care is less utilized in patients with non-cancer conditions.[19,20]

This study aimed to examine potential changes from 2006 through 2016 in the association between socioeconomic position and the use of health-care services within three months before death in patients dying from cancer and non-cancer diseases, respectively.

Materials and Methods

We conducted a registry-based study encompassing all adult Danish citizens who died of cancer or one of seven non-cancer diseases between January 1, 2006 and December 31, 2016. The unique personal identification number of every Danish resident enabled individual-level linkage of national registries.[21] Health-care services in Denmark are provided free of charge due to funding by taxes, facilitating equity in access to healthcare for all residents.[22]

In line with Danish law, approval from an ethics committee is not required for observational studies, but the study was reported to the Danish Data Protection Agency (record number: 2015-57-0002) and registered at Aarhus University (record number: 2016-051-000001/977).

Characteristics of Decedents

All adult decedents registered with cancer or a non-cancer diagnosis as cause of death were identified using the Danish Registry of Causes of Death. The Danish Registry of Causes of Death is a nationwide registry encompassing information on cause and date of death from death certificates filled for all decedents with a completeness of approximately 97%.[23] Non-cancer death diagnoses included diabetes, dementia, heart failure, ischemic heart disease, stroke, chronic liver disease, and chronic obstructive pulmonary disease, selected according to the Dartmouth Atlas Project.[24]

Due to data availability, only decedents dying between April 1, 2011 and December 31, 2016 were included in the analyses of intensive care unit admissions, home care nurse visits, and non-medical home care provision. Furthermore, only decedents dying between April 1, 2009 and December 31, 2016 were included in the analyses of hospice admissions (see registry descriptions below).

We obtained data regarding decedents' age at death, sex, cohabitation, and residential municipality using the Danish Civil Registration System, an administrative registry containing individual-level data on all Danish residents.[25]

Information on comorbidities for all decedents was retrieved using the nationwide Danish National Registry of Patients, which encompasses data from in- and outpatient hospital contacts since 1995.[26] Thus, we calculated a comorbidity score of comorbidities at time of death according to the Charlson Comorbidity Index. The comorbidity score was calculated from weights of 19 selected conditions, excluding the disease causing death, based on all diagnoses from hospital contacts during the final 10 years before death.[27,28]

Socioeconomic Position

Information on socioeconomic position was based on individual-level data on patients' education and household income from the national authority on statistics, Statistics Denmark.[29,30] The framework provided by the International Standard Classification of Education 2011 (ISCED) was used to define levels of education: low (ISCED levels 0–2, primary and lower secondary education), middle (ISCED levels 3–5, upper secondary education up to bachelor's or equivalent level), and high educational level (ISCED levels 6–8, equivalent to bachelor's level or more).[31] Income levels were defined from estimation of the mean annual household income during the five-year period preceding the year of death. Income levels were defined as low income level if the mean annual household income of the decedent was below 50% of the national median, middle-income level if it was 50–100% of the national median, and high if it was above the national median. Statistics Denmark was used to gain information of national medians of household income in the year of death.[32]

Hospital Contacts

Using the Danish National Registry of Patients, we gained information on all hospital contacts.

Previous studies have estimated a positive predictive value of 98.7% for the coding of intensive care unit admissions.[33] Accordingly, data on the date of discharge from an intensive care unit had a completeness below 78.7% before 2011 but 95.1% in 2015.[34] We therefore decided to restrict the analyses on intensive care admissions to decedents who died between April 1, 2011 and December 31, 2016. Information on hospital-based specialist palliative care included no detailed information on the amount of specialist palliative care provided. Data on hospice admissions were not registered before 2009. Hence, we only included decedents who died between April 1, 2009 and December 31, 2016 in analyses on hospice admissions.

General Practice Contacts

In Denmark, 98% of the residents are assigned to a general practitioner.[35] Data on general practice contacts, ie, number of in-practice contacts and home visits, were retrieved from the National Health Service Registry. The registry has been effective since 1990 and encompasses data on activities in the primary care health setting from information on expenses reimbursed by the National Health Insurance.[35]

Home Care Provision

Data on home care, divided into categories of home care nursing and non-medical home care, were retrieved from Statistics Denmark. We extracted data on the number of home care nurse visits and number of days with non-medical home care provision. Non-medical home care included information on personal care (eg, help showering and getting out of bed) but not on the extent of care provided.

In Denmark, home care is provided free of charge for all residents by the municipalities. Data on municipal care services have been collected from the municipalities and into Statistics Denmark from 2006 and onwards.[22] Since 2011, indicators of home nursing and non-medical home care provision have been collected, but data collection has not been complete.[36] Therefore, the analyses of home nursing and non-medical home care provision were restricted to decedents who died between April 1, 2011 and December 31, 2016 who were residents in municipalities with valid data collection.[37]

Statistical Analysis

According to socioeconomic position, we estimated and graphed the proportion of cancer and non-cancer patients, receiving the included health-care services within three months before death and the proportion of patients who died during a hospital admission.

We estimated median total bed days in hospital, intensive care unit or hospice as well as median number of emergency room visits, general practice contacts, home care nurse visits, and days with non-medical home care provision during the three months leading up to death in cancer and non-cancer patients.

For cancer and non-cancer patients, respectively, we computed adjusted differences in mean use of the included health-care services for patients with middle and high educational level, compared with patients with low educational level as well as for patients with middle and high income level, compared with patients with low income level. We used a linear regression model with robust variance estimator to calculate differences in means adjusted for age at death, sex, comorbidity, cohabitation, and residential municipality. For the analyses of difference in mean number of home nurse visits, however, we used robust regression since we discovered several outliers, assumedly caused by registration error. In analyses regarding income level, cohabitation was not included as a covariate due to its correlation with household income. Subsequently, the adjusted differences in mean use of the various health-care services were graphed according to calendar year of death.

Analyses of home care nurse visits and non-medical home care provision included only decedents living in municipalities where recordings on these indicators were considered valid during the three months before date of death.

Due to incomplete registration of education data before 1973, we addressed missing data on education using the missing indicator method, which groups missing values into a distinct category.[38]

We performed all analyses using a remote server at Statistics Denmark using STATA 16.1 (StataCorp. 2019. Statistical Software: Release 16. College Station, TX: StataCorp LP).

Results

We included 169,694 individuals of 18 years or older with cancer as cause of death and 180,223 individuals with one of the included non-cancer causes of death during January 1, 2006–December 31, 2016 (Supplementary Table 1).

Socioeconomic Position and Healthcare Utilization
Cancer Patients

We found limited socioeconomic disparities in the proportion of cancer patients being admitted to hospital, being admitted to intensive care, visiting an emergency room, seeing a general practitioner, receiving home care nurse visits, and dying in hospital (Supplementary Figures 1 and 2). An association with socioeconomic position was found for the use of hospice and hospital-based specialist palliative care, as higher socioeconomic position was associated with higher use (Supplementary Figures 1 and 2).

During the 2006–2016 period, the use of hospital-based specialist palliative care increased substantially whereas decreasing proportions of patients died in hospital (Supplementary Figures 1 and 2).

Adjusted estimates of the associations between socioeconomic position and use of the various health-care services stayed relatively stable during the 2006–2016 period (Figures 1 and 2). However, socioeconomic disparities in use of hospital-based specialist palliative, particularly according to level of income, have increased over time. Thus, the adjusted difference in the proportion of cancer patients affiliated with hospital-based specialist palliative care increased from 0.01 (95% confidence interval (CI): 0.01; 0.02) in 2006/2007 to 0.12 (95% CI: 0.09; 0.14) in 2016 for the high income level when compared with the low income level (Figure 2).

Non-Cancer Patients

During the study period, we found limited socioeconomic disparities in the proportion of non-cancer patients being admitted to hospital, visiting an emergency room, seeing a general practitioner, being admitted to hospice, or receiving specialist palliative care within three months before death (Supplementary Figures 3 and 4). Yet, an association between socioeconomic position, particularly income level, and intensive care unit admissions and place of death was found. Thus, the higher income level, the higher risk of being admitted to intensive care or dying in hospital (Supplementary Figure 4). Moreover, we found that socioeconomic position was inversely associated with the proportion of patients receiving home care nurse visits and non-medical home care, that is, the higher socioeconomic position the lower use (Supplementary Figures 3 and 4).

During the 2006–2016 period, we discovered the proportion of patients dying in hospital to be decreasing (Supplementary Figures 3 and 4). Fluctuations in the adjusted relative use of health-care services for non-cancer patients according to socioeconomic position were limited during 2006–2016 (Figures 3 and 4). In patients with middle income compared with patients with low income, however, the adjusted difference in proportions of patients dying while admitted to hospital decreased from 0.07 (95% CI: 0.05; 0.08) in 2006/2007 to 0.02 (95% CI: 0.01; 0.04) in 2016 (Figure 4).

Discussion

We found educational and income level to be associated with use of hospital-based specialist palliative care for cancer patients, that is, the higher socioeconomic position, the higher use. Moreover, high income level in non-cancer patients was associated with increased risk of dying in hospital. In both patients dying from cancer and non-cancer diseases, we found number of days with non-medical home care provision to be inversely associated with socioeconomic position, that is, the higher socioeconomic position, the lower use.

During the 2006–2016 period, the socioeconomic disparity in use of hospital-based specialist palliative care increased substantially for patients dying from cancer, though the proportion of cancer patients receiving specialist palliative care increased. Conversely, in non-cancer patients, the socioeconomic disparity gap decreased in terms of risk of dying in
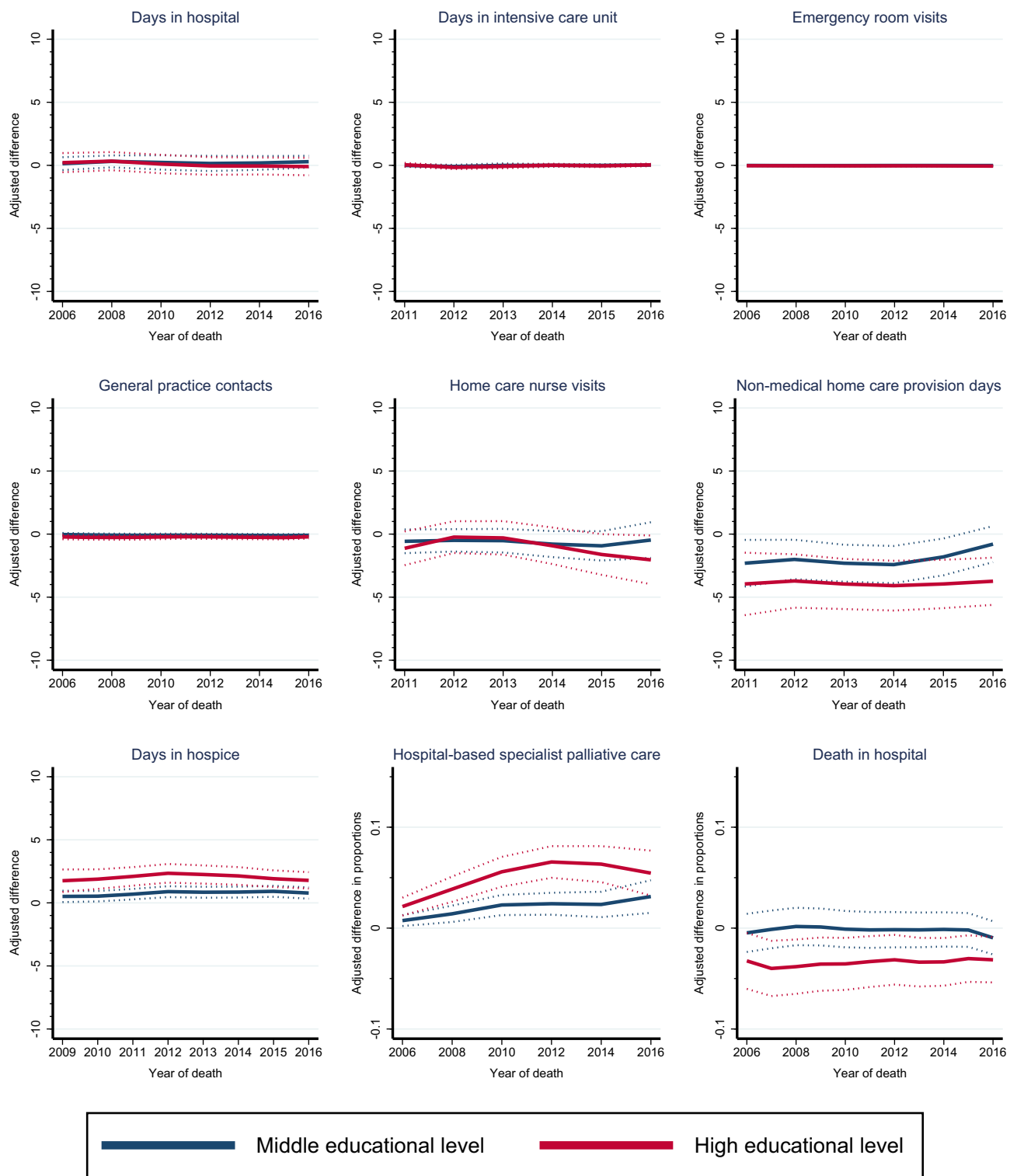
Figure 1 Adjusted mean difference in use of health-care services for cancer patients according to calendar year of death and middle and high educational level when compared with low educational level.

hospital, although differences were modest. However, in both patient populations, we found limited socioeconomic disparities and changes over time in the use of hospital, intensive care, emergency room, general practice, home care nurse, and hospice during the study period.
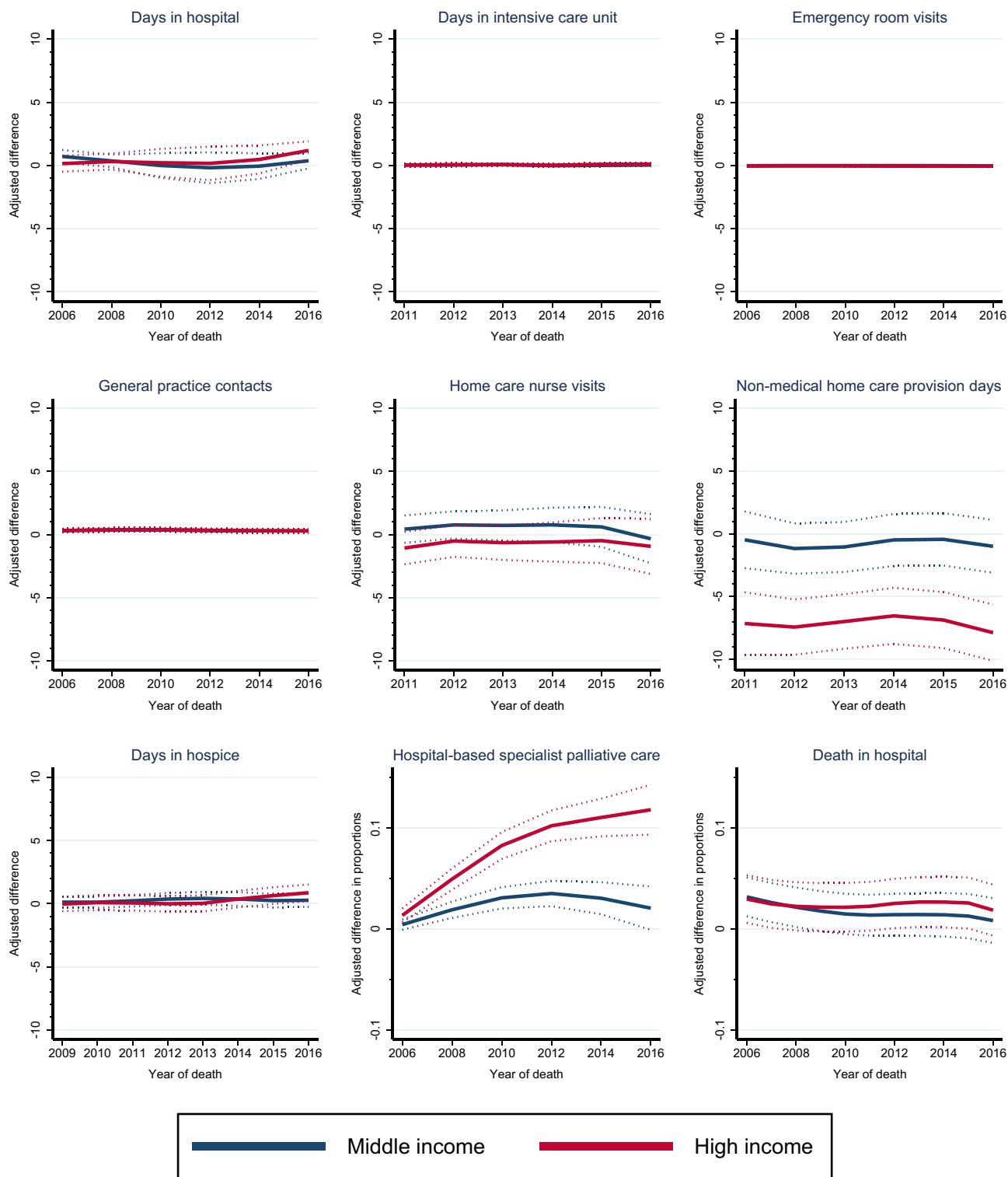
Figure 2 Adjusted mean difference in use of health-care services for cancer patients according to calendar year of death and middle and high income level when compared with low income level.

The nationwide design within the setting of a universal healthcare system, including the possibility of individual-level linkage of national and medical registries, were major strengths of the current study.[26,33,39] Furthermore, decedents were identified using the Danish Registry of Causes of Death, an approximately 97% complete registry, wherefore selection bias was unlikely.[23]
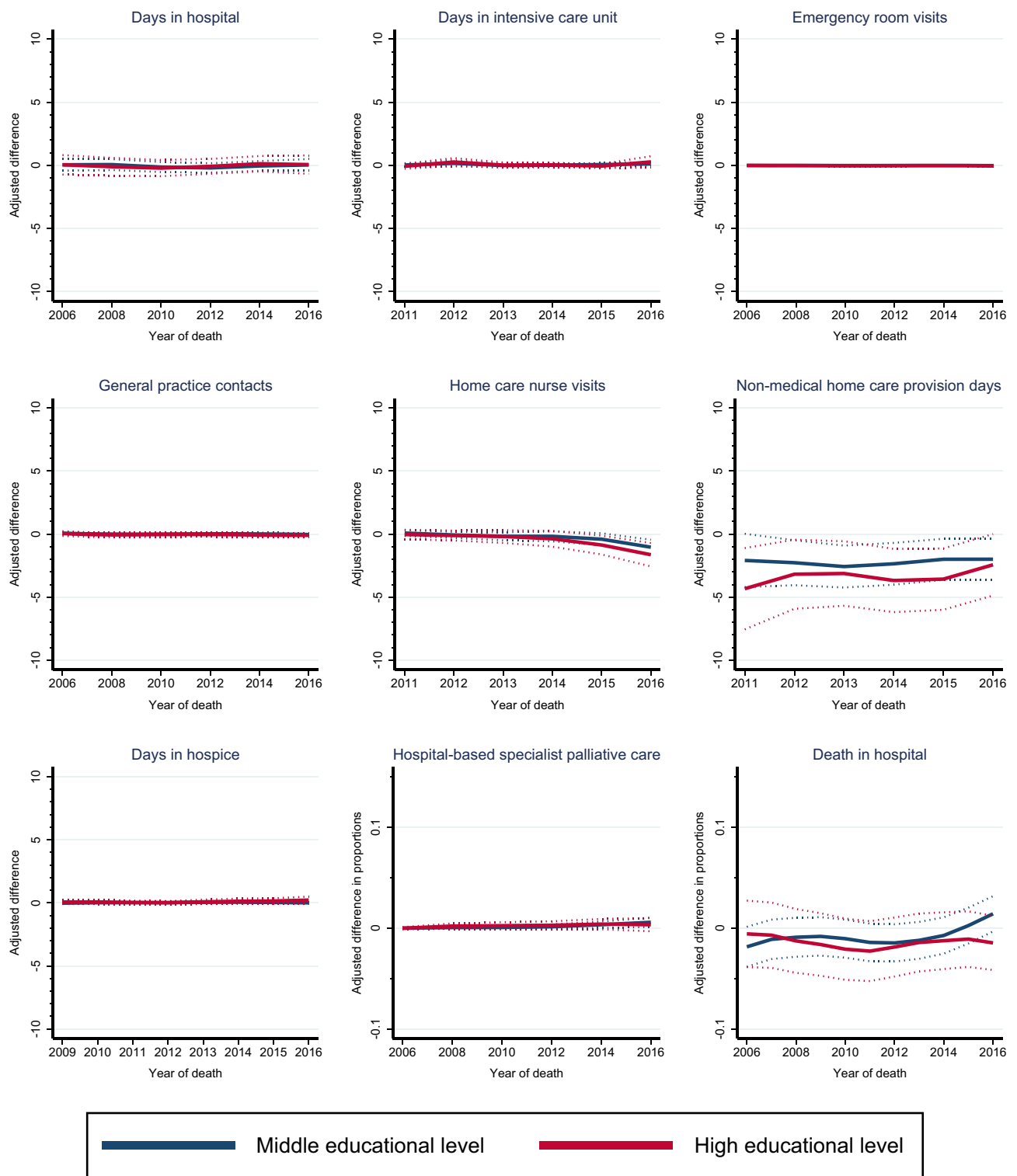
Figure 3 Adjusted mean difference in use of health-care services for non-cancer patients according to calendar year of death and middle and high educational level when compared with low educational level.

Since missing data on education was caused by registration procedure,[38] we believe that it was equally distributed in the comparison groups, wherefore the risk of differential information bias is low.

We cannot exclude the risk of residual confounding of our results, though analyses were adjusted for multiple potential confounders. There could also be confounding from unmeasured factors, eg, palliative care
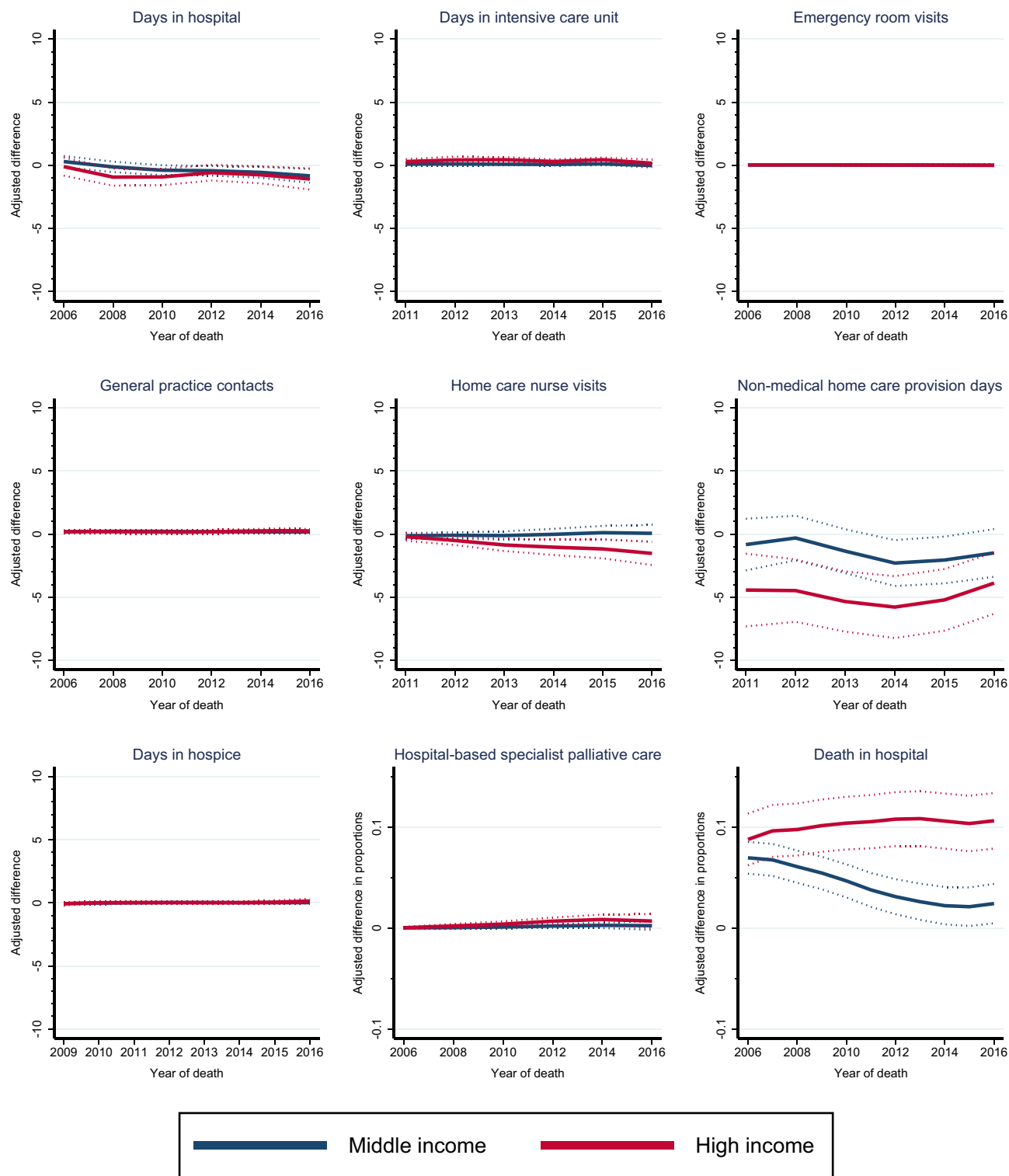
Figure 4 Adjusted mean difference in use of health-care services for non-cancer patients according to calendar year of death and middle and high income level when compared with low income level.

needs and lifestyle factors. However, these conditions are not likely to explain the temporal trends in socio-economic disparity in end-of-life care, as we assume they have not changed considerably during the study period.

Our findings of increasing socioeconomic disparities in cancer patients receiving hospital-based specialist palliative care over recent years are not in line with overall political efforts aimed at reducing socioeconomic disparities in health and access to healthcare.[1,40] Additionally, the capacity of hospital-based specialist palliative care in Denmark has increased considerably during the study period.[41] This is consistent with our findings of increasing proportions of cancer patients affiliated with hospital-based specialist palliative care at the end of life. Hence, the fact that cancer patients with high socioeconomic position were favored in access to hospital-based specialist palliative care indicates faster improvement in care for patients with high socioeconomic position compared with the low. This may be explained by stronger support networks, knowledge of specialist palliative care, and understanding of navigating the healthcare system in high socioeconomic groups.[42] However, the socioeconomic disparities in access to hospital-based specialist palliative care may to some extent be mitigated by the greater use of non-medical home care in patients with low socioeconomic position, which we found in the current study. Yet, the greater use of non-medical home care in patients with low socioeconomic position may reflect a greater need related to more extensive psychosocial challenges in these patients, including less support from family or informal caregivers. Thus, patients with low socioeconomic position are traditionally the most vulnerable, wherefore the lower proportion of patients affiliated with hospital-based specialist palliative care in this group warrants consideration since it may reflect unmet palliative needs and poor quality of care, not taking individual circumstances into account.

To date, we are not aware of previous studies examining temporal trends in socioeconomic disparities in end-of-life care, including various health-care services, stratified into patients dying from cancer and non-cancer diseases. However, recent studies from England and Canada have examined essential end-of-life outcomes according to socioeconomic position and potential temporal trends.[14,15] By measuring death during hospital admission as a proxy for poor quality of care at the end of life, Barratt et al (2017) explored trends in socioeconomic disparities over time in a nationwide cohort in England from 2001 to 2012.[14] They found that political efforts to advance end-of-life care did not reduce disparities although the overall quality of care was improved, since patients with low socioeconomic position still had a greater risk of dying in hospital despite an overall reduction in hospital deaths.[14] In the Canadian study, Mondor et al examined socioeconomic disparity trends in place of death and use of palliative care interventions.[15] They found it to be persisting that patients with low socioeconomic position were less likely to die in their homes and have palliative care provided prior to death, despite overall improvements in these outcomes during the 2009–2016 period.[15]

In contrast to the English and Canadian results, we found non-cancer patients with high income level to be more likely to die in hospital compared with patients with low income level despite an overall decrease in hospital deaths. In Denmark, specialist palliative care capacity is limited, contrary to England and Canada,[15,43,44] and almost exclusively offered to patients with cancer. Hence, non-cancer patients in Denmark, particularly high-income patients, may tend to be treated more aggressively towards the end of life due to insufficiently tailored palliative care interventions and consequently die during hospital admissions. Still, our findings regarding a tendency of increased socioeconomic disparities in cancer patients' use of hospital-based specialist palliative care despite increased specialist palliative care capacity[41] are in line with the results from Canada.

Contrary to results from other studies, including a large systematic review by Davies et al, we did not discover the expected substantial socioeconomic disparities in end-of-life care, favoring patients with high socioeconomic position.[10–13] Overall, in both cancer and non-cancer patients, we found limited socioeconomic disparities in use of hospital, intensive care, emergency room, general practice, home care nurse, and hospice and no trends over time. This may indicate that the universal tax-financed healthcare system in Denmark provides more equality in access to health-care services at the end of life compared with other health-care systems. Still, we cannot conclude that this reflects equity in care and good quality of care for patients at the end of life, and it should be taken into account that there are considerable differences in the structure and financing of health-care systems in Western countries and that organization and development of palliative care also varies.[45] However, in light of political strategies throughout the study period trying to diminish the socioeconomic disparity gap in health and access to healthcare,[1,40] the increasing disparities in care at the end of life regarding specialist palliative care warrant consideration.

Conclusions

Aligning with health policy priorities in the Danish universal tax-supported healthcare system, there are in general limited differences in use of health-care services at the end of life according to socioeconomic position in patients dying from cancer and patients dying from non-cancer diseases, respectively.

However, for patients dying from cancer, we found increased socioeconomic disparities in use of hospital-based specialist palliative care during the study period along with non-medical home care being more frequently provided to patients with low socioeconomic position regardless of underlying disease. Hence, focus on exploring this discrepancy is needed in order to secure access to appropriately tailored palliative care at the end of life regardless of socioeconomic position.

Abbreviations

CI, Confidence interval; ISCED, International Standard Classification of Education 2011.

Data Sharing Statement

In accordance with Danish law, data retrieved for the current study cannot be distributed or made available to other parties and are, therefore, only available, as they have been presented in the paper.

Ethics Approval and Informed Consent

In line with Danish law, we retrieved approval from the Danish Data Protection Agency (record number 2015-57-0002) by registration at Aarhus University (Aarhus University record number 2016-051-000001/977), but no approvals from ethics committees and consents from patients are required in observational studies.

Consent for Publication

All authors have approved the manuscript and given their consent for submission and publication.

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Disclosure

The authors report no conflicts of interest in this work.

References

1. World Health Organization. *Health 2020 - European Policy Framework and Strategy for the 21st Century.* World Health Organization Regional Office for Europe; 2013.
2. Marmot M. The health gap: the challenge of an unequal world. *Lancet.* 2015;386(10011):2442–2444. doi:10.1016/S0140-6736(15)00150-6
3. Mackenbach JP, Stirbu I, Roskam AJ, et al. Socioeconomic inequalities in health in 22 European countries. *N Engl J Med.* 2008;358(23):2468–2481. doi:10.1056/NEJMsa0707519
4. Marmot M, Bell R. Fair society, healthy lives. *Public Health.* 2012;126(Suppl 1):S4–s10. doi:10.1016/j.puhe.2012.05.014
5. Vestergaard AHS, Sampson EL, Johnsen SP, Petersen I. Social inequalities in life expectancy and mortality in people with dementia in the United Kingdom. *Alzheimer Dis Assoc Disord.* 2020;34(3):254–261. doi:10.1097/WAD.0000000000000378

6. Filc D, Davidovich N, Novack L, Balicer RD. Is socioeconomic status associated with utilization of health care services in a single-payer universal health care system? *Int J Equity Health*. 2014;13(1):115. doi:10.1186/s12939-014-0115-1

7. Riley GF, Lubitz JD. Long-term trends in Medicare payments in the last year of life. *Health Serv Res*. 2010;45(2):565–576. doi:10.1111/j.1475-6773.2010.01082.x

8. Christensen BJ, Gørtz M, Kallestrup-Lamb M. Medical spending in Denmark. *Fisc Stud*. 2016;37(3–4):461–497. doi:10.1111/j.1475-5890.2016.12119

9. Fien S, Plunkett E, Fien C, et al. Challenges and facilitators in delivering optimal care at the end of life for older patients: a scoping review on the clinicians' perspective. *Aging Clin Exp Res*. 2021;33(10):2643–2656. doi:10.1007/s40520-021-01816-z

10. Daugaard C, Neergaard MA, Vestergaard AHS, Nielsen MK, Johnsen SP. Socioeconomic inequality in drug reimbursement during end-of-life care: a nationwide study. *J Epidemiol Community Health*. 2019;73(5):435–442. doi:10.1136/jech-2018-211580

11. Davies JM, Sleeman KE, Leniz J, et al. Socioeconomic position and use of healthcare in the last year of life: a systematic review and meta-analysis. *PLoS Med*. 2019;16(4):e1002782. doi:10.1371/journal.pmed.1002782

12. Mason B, Kerssens JJ, Stoddart A, et al. Unscheduled and out-of-hours care for people in their last year of life: a retrospective cohort analysis of national datasets. *BMJ Open*. 2020;10(11):e041888. doi:10.1136/bmjopen-2020-041888

13. Neergaard MA, Brunoe AH, Skorstengaard MH, Nielsen MK. What socio-economic factors determine place of death for people with life-limiting illness? A systematic review and appraisal of methodological rigour. *Palliat Med*. 2019;33(8):900–925. doi:10.1177/0269216319847089

14. Barratt H, Asaria M, Sheringham J, Stone P, Raine R, Cookson R. Dying in hospital: socioeconomic inequality trends in England. *J Health Serv Res Policy*. 2017;22(3):149–154. doi:10.1177/1355819616686807

15. Mondor L, Wodchis WP, Tanuseputro P. Persistent socioeconomic inequalities in location of death and receipt of palliative care: a population-based cohort study. *Palliat Med*. 2020;34:269216320947964.

16. Sleeman KE, Davies JM, Verne J, et al. The changing demographics of inpatient hospice death: population-based cross-sectional study in England, 1993–2012. *Palliat Med*. 2016;30(1):45–53. doi:10.1177/0269216315585064

17. World Health Organization. Noncommunicable diseases; 2021.

18. Mathers CD, Loncar D, Samet J. Projections of global mortality and burden of disease from 2002 to 2030. *PLoS Med*. 2006;3(11):e442. doi:10.1371/journal.pmed.0030442

19. Knaul FM, Farmer PE, Krakauer EL, et al. Alleviating the access abyss in palliative care and pain relief-an imperative of universal health coverage: the Lancet Commission report. *Lancet*. 2018;391(10128):1391–1454. doi:10.1016/S0140-6736(17)32513-8

20. Bloom CI, Slaich B, Morales DR, Smeeth L, Stone P, Quint JK. Low uptake of palliative care for COPD patients within primary care in the UK. *Eur Respir J*. 2018;51(2):1701879. doi:10.1183/13993003.01879-2017

21. Mainz J, Hess MH, Johnsen SP. The Danish unique personal identifier and the Danish Civil Registration System as a tool for research and quality improvement. *Int J Qual Health Care*. 2019;31(9):717–720. doi:10.1093/intqhc/mzz008

22. Schmidt M, Schmidt SAJ, Adelborg K, et al. The Danish health care system and epidemiological research: from health care contacts to database records. *Clin Epidemiol*. 2019;11:563–591. doi:10.2147/CLEP.S179083

23. Helweg-Larsen K. The Danish register of causes of death. *Scand J Public Health*. 2011;39(7 Suppl):26–29. doi:10.1177/1403494811399958

24. Goodman DC, Esty AR, Fisher ES, Chang C. A report of the Dartmouth Atlas Project: trends and variation in end-of-life care for medicare beneficiaries with severe chronic illness. The Dartmouth Institute; 2011.

25. Schmidt M, Pedersen L, Sorensen HT. The Danish civil registration system as a tool in epidemiology. *Eur J Epidemiol*. 2014;29(8):541–549. doi:10.1007/s10654-014-9930-3

26. Schmidt M, Schmidt SA, Sandegaard JL, Ehrenstein V, Pedersen L, Sorensen HT. The Danish National Patient Registry: a review of content, data quality, and research potential. *Clin Epidemiol*. 2015;7:449–490. doi:10.2147/CLEP.S91125

27. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis*. 1987;40(5):373–383. doi:10.1016/0021-9681(87)90171-8

28. Thygesen SK, Christiansen CF, Christensen S, Lash TL, Sorensen HT. The predictive value of ICD-10 diagnostic coding used to assess Charlson comorbidity index conditions in the population-based Danish National Registry of Patients. *BMC Med Res Methodol*. 2011;11:1–6. doi:10.1186/1471-2288-11-83

29. Jensen VM, Rasmussen AW. Danish education registers. *Scand J Public Health*. 2011;39(7 Suppl):91–94. doi:10.1177/1403494810394715

30. Baadsgaard M, Quitzau J. Danish registers on personal income and transfer payments. *Scand J Public Health*. 2011;39(7 Suppl):103–105. doi:10.1177/1403494811405098

31. UNESCO. International standard classification of education ISCED 2011; 2011.

32. Statistics Denmark. INDKF201: main table for family income statistics by type of income, family type, population, price unit and unit; 2004–2019. Available from: www.statistikbanken.dk/INDKF201. Accessed June 22, 2021.

33. Christiansen CF, Christensen S, Johansen MB, Larsen KM, Tønnesen E, Sørensen HT. The impact of pre-admission morbidity level on 3-year mortality after intensive care: a Danish cohort study. *Acta Anaesthesiol Scand*. 2011;55(8):962–970.

34. Christiansen CF, Møller MH, Nielsen H, Christensen S. The Danish intensive care database. *Clin Epidemiol*. 2016;8:525–530. doi:10.2147/CLEP.S99476

35. Andersen JS, Olivarius Nde F, Krasnik A. The Danish national health service register. *Scand J Public Health*. 2011;39(7 Suppl):34–37. doi:10.1177/1403494810394718

36. Statistics Denmark. Elderly indicators; 2021. Available from: https://www.dst.dk/en/Statistik/dokumentation/documentationofstatistics/elderly—indicators. Accessed June 22, 2021.

37. Statistics Denmark. Home care provision, months of reporting by municipalities; 2018.

38. Pedersen AB, Mikkelsen EM, Cronin-Fenton D, et al. Missing data and multiple imputation in clinical epidemiological research. *Clin Epidemiol*. 2017;9:157–166. doi:10.2147/CLEP.S129785

39. Olivarius NF, Hollnagel H, Krasnik A, Pedersen PA, Thorsen H. The Danish national health service register. A tool for primary health care research. *Dan Med Bull*. 1997;44(4):449–453.

40. European Commision. EU health programme; 2003. Available from: https://ec.europa.eu/health/funding/key_documents_en#anchor2. Accessed June 14, 2021.

41. Timm HM, Jarlbæk TB, Jarlbæk L. Specialiseret palliativ indsats i Danmark mangler kapacitet og tilgængelighed. *Ugeskr Laeger*. 2017;179(26): V02170094.

42. Schou-Andersen M, Ullersted MP, Jensen AB, Neergaard MA. Factors associated with preference for dying at home among terminally ill patients with cancer. *Scand J Caring Sci*. 2016;30(3):466–476. doi:10.1111/scs.12265

43. Arias-Casais N, Garralda E, Rhee JY, et al. *EAPC Atlas of Palliative Care in Europe 2019*. Vilvoorde: EAPC Press; 2019.

44. Hill AD, Stukel TA, Fu L, et al. Trends in site of death and health care utilization at the end of life: a population-based cohort study. *CMAJ Open*. 2019;7(2):E306–E315. doi:10.9778/cmajo.20180097

45. Centeno C, Lynch T, Donea O, et al. *EAPC Atlas of Palliative Care in Europe 2013*. Full ed. Milan: EAPC Press; 2013.