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The impact of age at diagnosis on socioeconomic inequalities in adult cancer survival in England

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ABSTRACT

Background: Understanding the age at which persistent socioeconomic inequalities in cancer survival become apparent may help motivate and support targeting of cancer site-specific interventions, and tailoring guidelines to patients at higher risk.
Patients and methods: We analysed data on more than 40,000 patients diagnosed in England with one of three common cancers in men and women, breast, colon and lung, 2001–2005 with follow-up to the end of 2011. We estimated net survival for each of the five deprivation categories (affluent, 2, 3, 4, deprived), cancer site, sex and age group (15–44, 45–54, 55–64, and 65–74 and 75–99 years).
Results: The magnitude and pattern of the age specific socioeconomic inequalities in survival was different for breast, colon and lung. For breast cancer the deprivation gap in 1-year survival widened with increasing age at diagnosis, whereas the opposite was true for lung cancer, with colon cancer having an intermediate pattern. The 'deprivation gap' in 1-year breast cancer survival widened steadily from −0.8% for women diagnosed at 15–44 years to −4.8% for women diagnosed at 75–99 years, and was the widest for women diagnosed at 65−74 years for 5- and 10-year survival. For colon cancer in men, the gap was widest in patients diagnosed aged 55–64 for 1-, 5- and 10-year survival. For lung cancer, the 'deprivation gap' in survival in patients diagnoses aged 15–44 years was more than 10% for 1-year survival in men and for 1- and 5-year survival in women.
Conclusion: Our findings suggest that reduction of socioeconomic inequalities in survival will require updating of current guidelines to ensure the availability of optimal treatment and appropriate management of lung cancer patients in all age groups and older patients in deprived groups with breast or colon cancer.

1. Introduction

In spite of notable improvements in cancer survival in recent decades, socioeconomic inequalities in survival persist for the great majority of common cancers in adults [1–3]. For many cancers, however, survival has improved more rapidly for patients living in more affluent areas than for those living in deprived areas [4], including cancers of the breast, colon and lung [5–7]. These trends have led to wider socioeconomic inequalities ('deprivation gap') in survival in the last two decades, in spite of major policy initiatives designed to improve outcomes and reduce inequality [4,8].

A different picture is apparent for childhood cancers. The survival of children with cancer has improved more rapidly than that of adult patients in recent decades, chiefly reflecting notable advances in chemotherapy for many childhood cancers [9–11]. In addition, socioeconomic inequalities have not been observed for childhood cancers [12]. This may reflect a range of factors including the availability of effective treatments for many childhood cancers, the centralisation of care in specialist hospitals, and the high proportion of children treated in clinical trials [12].

These observations pose a question about the age-specific socioeconomic inequalities in cancer survival. Understanding this may help motivate and support targeting of interventions and tailoring guidelines to patients at higher risk. The answer to this question may also provide insights into the mechanisms responsible for socioeconomic inequalities in cancer survival and the potential contribution of differences in diagnosis. Against this

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background, we aimed to examine, the patterns of socioeconomic inequalities in survival for three common cancers in several age groups.

2. Patients and methods

All adults aged 15–99 years diagnosed in England with a first, invasive, primary malignant neoplasm of the breast (International Classification of Diseases, tenth revision [13] (ICD-10), C50), colon (C18) or lung (C33, C34) during the 5 years from 2001 to 2005, with follow-up to 31 December 2011 were considered for analysis. These three cancer sites are characterised by high incidence (allowing for more precise survival estimates by age and deprivation group), variable prognosis and a persistent 'deprivation gap' in survival in recent periods [1,3].

Standard exclusion criteria were used to decide whether a patient record was eligible for inclusion [1,14]. Cases were excluded if the cancer was only registered from the death certificate (DCO) (14,853 (3.5%)), or for unknown vital status or sex, duplicate registration, synchronous tumours, or invalid dates or sequences of dates (10,178 (2.4%)). Patients who had had a previous cancer of the same organ at any time since 1971 were also excluded (Table 1). One day was added to the survival time of patients for whom the dates of diagnosis and death were the same (zero survival), enabling the inclusion of these patients in analyses. Age at diagnosis was categorised in five groups (15–44, 45–54, 55–64, 65–74, and 75–99 years).

The Office for National Statistics (ONS) provides information on each patient's vital status (alive, dead, emigrated or lost to follow-up) and their postcode of residence at diagnosis, from which patients were assigned to one of five deprivation categories (from most affluent (1) to most deprived (5)). An ecological deprivation score was assigned to each patient based on the characteristics of the Lower Super-Output Area (LSOA) in which the patient was resident at the time of diagnosis, and the year of diagnosis. The LSOAs in England are small areas (mean population 1500), covering the whole of England and for which detailed data on housing, income and employment are available. These information can be used to characterise the level of the socioeconomic group of residents. These groups were defined by quintiles of the income domain score of the Indices of Multiple Deprivation (IMD) [15] of 34,378 LSOAs in England.

Net survival is the survival probability we would observe if the disease under study was the only cause of death. It may be interpreted as the survival of cancer patients after controlling for competing causes of death. This method is recommended for the estimation of cancer survival when the cause of death is either unknown or unreliable. It estimates the excess mortality due to cancer as the difference between the all-cause mortality experienced by cancer patients and the expected or 'background' mortality derived from life tables of all-cause death rates of the general population. We used cancer registry data to estimate all-cause mortality, and life tables to estimate the expected or background mortality in the general population. Background mortality varied between socioeconomic groups and geographic regions in England. Death records were assigned to deprivation categories using the postcode and LSOA. Abridged (5-year) life tables were completed and extended to age 99 years and smoothed using flexible parametric Poisson regression with spline functions to model the death rate. We then derived complete (single-year-of-age) life tables by sex, socioeconomic group, geographic region and calendar year for 2001–2009 (Cancer Research UK Cancer Survival Group, 2004). Life tables for 2010–2011 could not be constructed because the relevant data (death during 2010–2011) were unavailable, so life tables for 2009 were used for these years.

We estimated net survival every six months and up to 10 years after diagnosis for each of the five deprivation categories, cancer site, sex and each of the five age groups using the Pohar Perme estimator [16].

The 'deprivation' gap was quantified as the fitted difference between survival in the 'most affluent' and the 'most deprived', using weighted least-squares regression [17] for each cancer site, sex and age group. A negative gap indicates that net survival was lower in the most deprived group than the most affluent group. This gap was quantified for each year up to 10 years after diagnosis.

All analyses were carried out in Stata 13 [18], including net survival analyses with *stns* [19].

3. Results

A total of 405,796 patients diagnosed between 2001 and 2005 and followed up to 2011 were included in the analyses (Table 1). The three cancer sites are more commonly diagnosed at an older age, with very few patients diagnosed with lung and colon in the youngest age group 15–55 (Table 2). While breast and colon cancer are more common among affluent patients, the percentage of lung cancer patients diagnosed late in life (75–99) are almost double those in the affluent group (Table 2). Table 3 summarises the 1-, 5, and 10-year survival for each cancer. Patterns of the 'deprivation gap' up to 5 years by age group are presented in Fig. 1. Net survival up to 10 years after diagnosis for the most affluent and the most deprived groups in the three age groups 15–44, 55–64 and 75–99 years, for each of the three cancers and sex in England are presented in Fig. 2. Net survival could not be estimated for colon cancer in men in the deprived youngest age group 14–55, due to the small number of patients. The detailed estimates of 1-, 5- and 10-year net survival are presented in Appendices A–C.

The age-specific patterns of socioeconomic inequalities in survival differed between the three cancers. For breast cancer, the socioeconomic deprivation gap in 1-year survival widened with increasing age at diagnosis, whereas the opposite was true for lung cancer, with colon cancer having an intermediate pattern (Fig. 1, Table 3).

One-year survival for women with breast cancer for all ages and deprivation groups combined was high (97%). It was similar

Table 1
Number of patients eligible for analysis, exclusions, and number (%) of eligible patients included in analyses: three cancers, England, adults(15–99 years) diagnosed 2001–2005 and followed up to 2011.

Malignancy	ICD-10 code[a]	Eligible	Exclusions		Included	
			DCO[b]	Other[c]	Number	%
Colon	C18	90,928	3,129	1,880	86,378	95.0
Lung	C33, C34	155,555	8,991	1,032	145,532	93.6
Breast (women)	C50	183,885	2,733	7,266	173,886	94.6

[a] International Classifications of Diseases, tenth edition.
[b] Registration from a death certificate only (DCO): date of diagnosis unknown.
[c] Aged 100 years or over at diagnosis, sex or vital status unknown, sex-site error, invalid dates, missing deprivation category, or previous cancer of the same organ since 1971.

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