Origins of socio-economic inequalities in cancer survival: a review

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Background: Cancer survival is known to vary by socio-economic group. A review of studies published by 1995 showed this association to be universal and resilient to the many different ways in which socio-economic status was determined. Differences were most commonly attributed to differences in stage of disease at diagnosis.

Materials and methods: A review of research published since 1995 examining the association of cancer survival with socio-economic variables.

Results: An association between socio-economic status and cancer survival has continued to be demonstrated in the last decade of research. Stage at diagnosis and differences in treatment have been cited as the most important explanatory factors. Some research has evaluated the psychosocial elements of this association.

Conclusions: Socio-economic differences in cancer survival are now well documented. The explanatory power of stage at diagnosis, although great, should not detract from the evidence of differential treatment between social groups. Neither factor can completely explain the observed socio-economic differences in survival, however, and the importance of differences in tumour and patient factors should now be quantified.

Key words: cancer, deprivation, poverty, social class, socio-economic status, survival analysis

introduction

Strong evidence for socio-economic differences in cancer survival and mortality was revealed by a comprehensive review in the late 1990s, for many cancers and in many populations [1]. These variations were resilient to the variety of ways in which socio-economic status had been determined. Differences were greatest for malignancies of the breast, large bowel, bladder and body of the uterus, which have relatively good prognoses, and for which stage at diagnosis is a key prognostic factor.

Possible reasons for survival differences between social groups were also reviewed [2]. Stage at diagnosis was the factor most often cited, but its influence varied by anatomic site and between populations, and it was not the sole explanatory factor for socio-economic differences in survival in much of the research. The reasons for differences in stage at diagnosis between social groups were also unclear: neither delay in diagnosis nor differences in tumour aggressiveness appeared to explain the variation. Differences in treatment were also identified as contributory factors, but the patterns observed were difficult to interpret because of the absence of data on (or adjustment for) stage of disease in most studies. The authors concluded [2] that further study into the causes of socio-economic differences in survival was required, particularly in relation to treatment differentials and psychosocial factors.

In this review, we summarise research published in the last decade on the association between socio-economic status and cancer survival, and discuss current evidence for the possible explanations of these differences.

methods

Reproducible database searches of PubMed, EMBASE, Web of Knowledge and, for grey literature, NML Gateway, HMIC and SIGLE, were conducted [3–7]. The search terms used were designed to identify references that indexed or mentioned (i) cancer, (ii) survival analysis and (iii) socio-economic status, or their synonyms. Suitable papers were identified on the basis of the title and abstract. All studies that had cited the previous review [1] were also included. Details of these were obtained using the Web of Knowledge ‘cited reference’ facility [5]. Further applicable references cited by each selected paper were then identified by hand-searching the bibliographies. Papers that had been included in the previous review [1] or that were published before 1995 were excluded.

results

A large number of studies have examined socio-economic variation in cancer survival during the last decade [8–46] (Table 1). A large body of literature also exists on the joint effect of socio-economic status and ethnicity. Some authors describe
Table 1. Summary of studies examining the impact of socio-economic status upon cancer survival, 1995 onwards

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<tr>
<th>Ref. No.</th>
<th>First author (year)</th>
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<tbody>
<tr>
<td>8</td>
<td>Australian Institute of Health and Welfare (2003) Cancer survival in Australia 1992–1997: geographic categories and socioeconomic status</td>
<td>All malignancies combined, colorectal, lung, melanoma, breast, cervix, prostate and NHL</td>
<td>National cancer registry data: Australia</td>
<td>Relative survival analysis using deprivation- and geography-specific life tables</td>
<td>Areal measure of deprivation: quintiles of the index of relative socioeconomic disadvantage for the SLA of residence at diagnosis. SLAs have an average population size of 13 000.</td>
<td>Differences in relative survival observed for all cancers (both sexes), lung cancer (males), and for prostate and breast cancer. The largest differences were observed for prostate and breast cancer patients. No significant differences in socio-economic survival was observed for the other sex-site combinations examined. Significant 5-year relative survival rate ratios ranged from 1.04 (breast, female) to 1.40 (lung, males) in favour of the most affluent quintile.</td>
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<tr>
<td>9</td>
<td>Begum G (2004) Socio-economic deprivation and survival in bladder cancer</td>
<td>Bladder</td>
<td>Cancer registry data: England</td>
<td>Cause-specific survival</td>
<td>Areal measure of deprivation: quintiles of the Townsend score 1991 of the ED at diagnosis. EDs have an average population size of 500.</td>
<td>Significant differences observed in all-cause but not cancer-specific survival. Patient and provider delay was not associated with deprivation status, although the smoking status of patients did vary across the quintiles.</td>
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<tr>
<td>10</td>
<td>Boyd C (1999) Associations between community income and cancer survival in Ontario, Canada, and the United States</td>
<td>All malignancies</td>
<td>Cancer registry data: Canada (Ontario) and USA (9 SEER registries)</td>
<td>Net and relative survival using country- (and, for the USA, race-) specific life tables</td>
<td>Areal measure of deprivation: quintiles of the median household income of the 1991 census EA in Canada (median population 700) and the 1990 census tract (median population 3800) or county (median population 19 000) in the USA.</td>
<td>Five-year cause-specific survival rate ratios comparing affluent with deprived groups ranged from 1.05 (breast, Canada) to 1.48 (lung, USA).</td>
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<td>11</td>
<td>Ciccone G (2000) Access to hospital care, clinical stage and survival from colorectal cancer according to socio-economic status</td>
<td>Colorectal</td>
<td>Hospital-based sample: Italy</td>
<td>All cause survival</td>
<td>Individual information on education (years of schooling) used as a proxy for SES.</td>
<td>Non-significant increase in hazard of death according to education (HR 1.46 comparing &gt;8 years with ≤5 years, adjusted for age, sex, marital status, residence and stage). Years of schooling associated with both stage and delay.</td>
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<tr>
<td>12</td>
<td>Coleman MP Cancer survival trends in England and Wales 1971–1995: deprivation and NHS region (1999)</td>
<td>All malignancies</td>
<td>National cancer registry data: England and Wales</td>
<td>Relative survival analysis using deprivation- and region-specific life tables</td>
<td>Areal measure of deprivation: quintiles of the Carstairs score 1981 and 1991 of the ED at diagnosis. EDs have an average population size of 500.</td>
<td>For all malignancies, the difference in 5-year survival between the most-deprived and the most-affluent quintiles was 11%. Socio-economic differentials were observed for 44 out of the 47 malignancies examined in adults, but for none of the 11 childhood malignancies. Significant 5-year relative survival rate ratio ranged from 1.2 (lung, both sexes) to 1.5 (tongue, both sexes).</td>
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<td>14</td>
<td>Coleman MP (2004)</td>
<td>Trends and socioeconomic inequalities in cancer survival in England and Wales up to 2001. Twenty common adult malignancies; National cancer registry data: England and Wales; Relative survival analysis using deprivation- and region-specific life tables; Areal measure of deprivation: quintiles of the 1991 Carstairs score and the IMD 2000 income domain score (1998) of the electoral ward of residence at diagnosis. Electoral wards have an average population size of 5000. In the 33 sex-site combinations examined, the five-year relative survival rate ratio for the most recent period ranged from 1.40 (myeloma, men) to 1.06 (uterus) with three instances of the survival amongst the most-deprived quintile being greater than that of the most affluent quintile: brain, ovary (females) and pancreas (males).</td>
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<td>15</td>
<td>Dawkins FW (1995)</td>
<td>The impact of health insurance on an African-American population with colorectal cancer. Colorectal; Hospital-based cancer registry data: USA; Crude survival adjusted for age at diagnosis; Health insurance status at diagnosis. Health insurance status was a non-significant predictor of crude age-adjusted survival. No significant differences were observed within each insurance group with respect to stage of disease, location, or differentiation. The total number of cases included in the study was small (212).</td>
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<td>16</td>
<td>Edwards DM (1999)</td>
<td>Incidence and survival from upper aerodigestive tract cancers in the UK: the influence of deprivation. Digestive tract; Cancer registry data: England; Cox proportional hazards regression of cause-specific survival; Areal measure of deprivation: quintiles of the Carstairs score 1991 of the ED at diagnosis (average population 500). Differences in cause-specific survival documented. In multivariable analysis including age, stage, ethnicity and marital status a significant HR of 1.25 was observed.</td>
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<td>17</td>
<td>Fontana V (1998)</td>
<td>Socioeconomic status and survival of gastric cancer patients. Digestive tract; Analysis of a subset of cases enrolled in a case–control study: Italy; Cox proportional hazards regression of all cause survival; Individual data on years of schooling and occupation. Overall survival was associated with more than 5 years of education (5-year survival rate ratio 2.35) but not occupation. In multivariate analysis, both were found to be significant independent predictors of survival after adjusting for age, stage, grade and surgery. The affluent tertile had significantly higher survival than the deprived tertile in six out of 60 sex-site combinations examined in Canada and in 31 out of the 60 in the USA. Five-year net survival rate ratios varied from 1.20 (prostate, uterus in the USA and bladder amongst women in Canada) to 1.69 (lung, males in the USA).</td>
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<td>18</td>
<td>Gorey KM (1997)</td>
<td>An international comparison of cancer survival: Toronto, Ontario and Detroit, Michigan, metropolitan areas. Fifteen common adult malignancies; Cancer registry data: Canada and USA; Age-standardised net survival rates; Areal measure of deprivation: tertiles (18) and quintiles (19) of the ‘poverty’ threshold in the USA (1990 census) and the ‘low income’ threshold in Canada (1991 census) of the census tract of residence at diagnosis. Canadian census tracts have an average population of 4000, whilst USA census tracts have an average population of 5000. The affluent tertile had significantly higher survival than the deprived tertile in six out of 60 sex-site combinations examined in Canada and in 31 out of the 60 in the USA. Five-year net survival rate ratios varied from 1.20 (prostate, uterus in the USA and bladder amongst women in Canada) to 1.69 (lung, males in the USA). Results focus only on the inter-country differences between the USA and Canada and do not report survival rates for the most affluent groups.</td>
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<tr>
<td>19</td>
<td>Gorey KM (1998)</td>
<td>An international comparison of cancer survival: advantage of Toronto’s poor over the near-poor of Detroit. Seven common adult malignancies; Cancer registry data: Canada and USA; Areal measure of deprivation: tertiles (18) and quintiles (19) of the ‘poverty’ threshold in the USA (1990 census) and the ‘low income’ threshold in Canada (1991 census) of the census tract of residence at diagnosis. Canadian census tracts have an average population of 4000, whilst USA census tracts have an average population of 5000. The affluent tertile had significantly higher survival than the deprived tertile in six out of 60 sex-site combinations examined in Canada and in 31 out of the 60 in the USA. Five-year net survival rate ratios varied from 1.20 (prostate, uterus in the USA and bladder amongst women in Canada) to 1.69 (lung, males in the USA). Results focus only on the inter-country differences between the USA and Canada and do not report survival rates for the most affluent groups.</td>
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<td>20</td>
<td>Gorey KM (2000)</td>
<td>Fifteen common adult malignancies</td>
<td></td>
<td>Age-standardised net survival rates</td>
<td></td>
<td>Results focus only on the inter-country differences between the USA and Canada and do not report survival rates for the most affluent groups.</td>
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<td>21</td>
<td>Gorey KM (2000)</td>
<td>Breast and prostate</td>
<td></td>
<td>Areal measure of deprivation: tertiles [20, 21], quintiles [22] and deciles [21] of the ‘poverty’ threshold in the USA (1990 census) and the ‘low income’ threshold in Canada (1991 census) of the census tract of residence at diagnosis. Canadian census tracts have an average population of 4000, whilst USA census tracts have an average population of 5000.</td>
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<td>22</td>
<td>Gorey KM (2003)</td>
<td>Breast</td>
<td></td>
<td>Five-year age-standardised crude survival by deprivation category and country</td>
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<td>Survival was significantly lower amongst the lowest income tertile in Hawaii for prostate cancer (5-year crude survival rate ratio 1.18) but not for Toronto, or in either locality for breast cancer. For patients under 65 years of age, a significant association was observed for breast cancer in Hawaii but not Ontario or in either locality for prostate cancer (rate ratio 1.14). Decile-based analyses replicate these patterns.</td>
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<tr>
<td>23</td>
<td>Harvey S (1997)</td>
<td>Prostate</td>
<td>Birth cohort study: Norway</td>
<td>Hazard regression of all cause mortality and relative survival, using socio-economic-marital-specific life tables</td>
<td>Individual socioeconomic status determined by both educational level and occupation.</td>
<td>Predicted 5-year relative survival 7% higher among the higher educated for localised disease (rate ratio 1.10) and 15% higher for regional or distant disease (rate ratio 1.60).</td>
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<td>24</td>
<td>Kravdal Ø (2000)</td>
<td>Twelve common malignancies</td>
<td>Census and cancer registry data: Norway</td>
<td>Poisson regression modelling of cancer-specific mortality</td>
<td>Individual data on education, income and occupation.</td>
<td>Comparing low with high number of years of education, significant HRs ranged from 1.28 (pancreas, women) to 1.72 (bladder, men). No significant association was observed for cancers of the stomach or cervix. Differences were also observed by income and occupation and continued to be significant after accounting for stage of disease.</td>
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<tr>
<td>Reference</td>
<td>Study</td>
<td>Malignancies</td>
<td>Registry Data</td>
<td>Measures of Deprivation</td>
<td>Community Characteristics</td>
<td>Findings</td>
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<td>Mackillop WJ (1997)</td>
<td>15 common malignancies</td>
<td>Cancer registry data: Canada</td>
<td>Cox proportional hazards regression of cause-specific survival</td>
<td>Areal measure of deprivation: categories of community median income on the basis of EA at diagnosis (average population 700) or census subdivision where EA data was missing (average population 10 000).</td>
<td>Significant differences in survival for most cancers after controlling for age, sex and year of diagnosis in the multivariable models. Non-significant associations were observed for stomach, ovary, testis and Hodgkin’s disease. Significant adjusted survival HRs ranged from 1.15 (lung) to 1.47 (head and neck).</td>
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<td>McDavid K (2003)</td>
<td>Colorectal, lung, breast, prostate</td>
<td>Cancer registry data: USA</td>
<td>Multivariable modelling of relative survival analysis using age-, sex-, race- and period-specific life tables</td>
<td>Individual health insurance status.</td>
<td>Differences by health insurance observed for all four malignancies examined (3-year survival rate ratios range from 1.16 for breast cancer to 1.76 for lung cancer). Controlling for treatment received reduced the differences for colorectal and prostate cancers, but not for lung or breast cancers.</td>
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<td>Moran A (2004)</td>
<td>Bladder</td>
<td>Cancer registry data: England</td>
<td>Cause-specific survival</td>
<td>Areal measure of deprivation: quintiles of the Townsend score of the ED at diagnosis (average population 500).</td>
<td>For women, a significant difference in cause-specific survival was observed (6-month survival rate ratio comparing most affluent quintile to most deprived 1.47). This association was not observed amongst men.</td>
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<td>Nevinham A (2003)</td>
<td>Oesophagus and stomach</td>
<td>National cancer registry data: England</td>
<td>Crude and relative survival</td>
<td>Areal measure of deprivation: quintiles of the Carstairs score 1981 and 1991 of the ED at diagnosis. EDs have an average population size of 500.</td>
<td>A significant association was observed between 5-year relative survival and deprivation for women with oesophageal cancer, but not for men with oesophageal cancer or for gastric cancer in either sex. Actual rates were not reported.</td>
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<tr>
<td>Paterson IC (2002)</td>
<td>Head and neck</td>
<td>Cancer registry data: England and Wales</td>
<td>Relative survival using national life tables</td>
<td>Areal measure of deprivation: quintiles of the Carstairs score 1991 of the ED at diagnosis. EDs have an average population size of 500.</td>
<td>Survival differences mainly evident between the top two and bottom three quintiles of deprivation in the first 18 months after diagnosis. Moderate differences in 5-year relative survival (rate ratio 1.11).</td>
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<tr>
<td>Pollock AM (1997)</td>
<td>Breast, lung and colorectal cancer incidence and survival in South Thames Region, 1987-1992: the effect of social deprivation</td>
<td>Cancer registry data: England</td>
<td>Relative survival using national life tables</td>
<td>Areal measure of deprivation: deciles of the Townsend score 1991 of the ED at diagnosis. EDs have an average population size of 500.</td>
<td>Lower survival rates observed for the most deprived deciles compared with the most affluent deciles for all three malignancies. Moderate effects: 5-year relative survival rate ratios 1.18 (lung), 1.23 (breast) and 1.25 (colorectal).</td>
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<tr>
<td>32</td>
<td>Potosky AL (1997)</td>
<td>Breast cancer</td>
<td>Cancer registry data: USA</td>
<td>Cox proportional hazards regression of cause-specific survival using health care system and other area-based socio-economic variables as covariates</td>
<td>Health care delivery system: HMOs versus fee-for-service settings and areal measures of household income and education based upon the census tract of residence at diagnosis (average population 5000).</td>
<td>Lower survival in fee-for-service setting compared to those registered in HMOs even after adjustment for age, race, SES, stage and comorbidity in one of the two settings examined (10-year adjusted cause-specific HR 1.43). Hazard ratio gradients by areal education level remain evident even after adjustment for health care setting.</td>
</tr>
<tr>
<td>33</td>
<td>Rosengren A (2004)</td>
<td>All malignancies</td>
<td>Cohort study conducted using a subset of data from a randomised intervention study: Sweden</td>
<td>Cox regression using occupation as a covariate</td>
<td>Occupational social class (five groups) determined by profession at entry into the trial in 1970.</td>
<td>The crude relative risk for an unskilled or semi-skilled occupation compared to the professional and executive group was 1.69 for all cancers but 3.16 for respiratory related cancers. The relative risks were not substantially altered by adjustment for age, smoking and alcohol intake (1.66 and 3.45 respectively). There was no evident occupational ‘gradient’: the remaining manual and non-manual occupational groups displayed similar risks to the unskilled or semi-skilled and professional and executive men, respectively.</td>
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<tr>
<td>34</td>
<td>Rosso S (1997)</td>
<td>All malignancies</td>
<td>Cancer registry: Italy</td>
<td>Cox regression using socio-economic variables as covariates</td>
<td>Individual socio-economic status determined by census measured educational level and housing tenure.</td>
<td>Overall, individuals with university level education displayed the highest survival. For cancers with a good prognosis, men educated to the highest level had significantly better survival (rate ratio 1.49). The magnitude of this association was smaller in women and non-significant (rate ratio 1.09). Cancers with poorer prognoses displayed the converse pattern (rate ratios males 1.09 and females 1.72) but neither association was significant. Patterns by housing tenure are reported to be similar.</td>
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<tr>
<td>Schrijvers CTM (1995)</td>
<td>Lung, breast, colorectum, bladder, prostate, stomach, pancreas, ovary, uterus and cervix</td>
<td>Calculation and modelling of relative survival using a national life table</td>
<td>Areal measure of deprivation: quintiles of the Carstairs score 1981 of the ED at diagnosis. EDs have an average population size of 500.</td>
<td>Better survival amongst the affluent observed for lung, breast, prostate, uterus and cervix and for males with bladder cancer. Statistically significant adjusted HRs for the most deprived quintile compared to the most affluent ranged from 1.13 (lung) to 1.47 (breast). The addition of stage of diagnosis to multivariate models of relative survival did cause not large changes in the HRs. Deprivation differences were greatest for cancer with better prognoses.</td>
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<td>Singh GK (2004)</td>
<td>All malignancies</td>
<td>Cancer registry data: USA (SEER database, 14% coverage of US population)</td>
<td>Cause-specific survival analysis</td>
<td>For all cancers combined, the 5-year cause-specific survival rate ratio comparing patients living in the richest 20% with the poorest 10% was 1.24 for men and 1.19 for women. For cervix cancer, the survival rate ratio comparing high to low educational groups was 1.08.</td>
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<tr>
<td>Singh GK (2004)</td>
<td>Cervix</td>
<td>Cancer registry data: USA (SEER database, 14% coverage of US population)</td>
<td>Census poverty rate (as above) in addition to the percentage of the tract or county with at least a high school diploma.</td>
<td>Weak association for breast and prostate cancer, with adjustment for treatment, stage, co-morbidity, and teaching status of hospital, but not for the other 13 malignancies. For breast the adjusted relative risk of death ranged from 1.28 to 1.79 and for prostate from 1.13 to 5.55 depending on the way SES was defined.</td>
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<td>Stavraky KM (1996)</td>
<td>Fifteen common malignancies</td>
<td>Clinical trial data: Canada</td>
<td>Cox regression using socio-economic variables as covariates</td>
<td>Crude survival for the lowest SES group was significantly lower than for the highest SES group, but relative survival displayed the opposite trend whereby survival was best in the lowest socioeconomic quintile (5-year relative survival rate ratio comparing high to low SES 0.85).</td>
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<td>Supramaniam (1998)</td>
<td>Breast</td>
<td>Cancer registry data: Australia (New South Wales)</td>
<td>Relative survival analyses using state- and deprivation-specific life tables</td>
<td>Crude survival for the lowest SES group was significantly lower than for the highest SES group, but relative survival displayed the opposite trend whereby survival was best in the lowest socioeconomic quintile (5-year relative survival rate ratio comparing high to low SES 0.85).</td>
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<td>Thomson CS (2001)</td>
<td>Breast</td>
<td>Cancer registry and audit data: Scotland</td>
<td>Kaplan–Meier and Cox regression analysis of all cause and cause-specific mortality</td>
<td>Differences in cause-specific survival were ~9% (both data sets, rate ratio 1.15) 5 years after diagnosis and 10% (registry data, rate ratio 1.22) or 13% (audit data, rate ratio 1.27) 10 years after diagnosis.</td>
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<td>42</td>
<td>Twelves (1998)</td>
<td>Breast</td>
<td>Audit data: Scotland</td>
<td>Kaplan–Meier and Cox regression analysis of all cause mortality</td>
<td>Areal measure of deprivation: three categories based upon quintiles of the Carstairs score. Year and geographic basis not specified.</td>
<td>Crude survival was higher in the most-affluent quintile in comparison to the most-deprived (rate ratio 1.12). Adjusting for prognostic factors, including ER status and stage of disease and treatment factors, reduced the rate ratio to 1.07 (non-significant).</td>
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<tr>
<td>43</td>
<td>West Midlands Cancer Intelligence Unit (2002)</td>
<td>Breast, cervix, colorectum, lung, prostate, upper gastrointestinal</td>
<td>Cancer registry: England</td>
<td>Relative survival analysis</td>
<td>Areal measure of deprivation: quintiles of the Townsend score 1991 of the ED at diagnosis. EDs have an average population size of 500.</td>
<td>Survival is generally higher among the affluent with 5-year relative survival rate ratios ranging from 1.02 to 3.17. The exceptions are pancreatic (males) and stomach (females) cancer in the earlier time period and oesophagus (women) and stomach (males) in the later time period.</td>
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<tr>
<td>44</td>
<td>Whynes DK (2003)</td>
<td>Colorectum</td>
<td>Clinical data from RCT: England</td>
<td>Linear regression modelling of age at death using deprivation and stage of disease as covariates</td>
<td>Areal measure of deprivation: IMD 2000 score of the ward of GP practice at diagnosis, treated as a continuous variable. Wards have an average population size of 500.</td>
<td>Females in the least-deprived practice predicted to live 1.1 years longer than females in the most-deprived practice.</td>
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<td>45</td>
<td>Wrigley H (2003)</td>
<td>Colorectum</td>
<td>Colorectal cancer audit of all cases diagnosed in one health region during a 3-year period: England</td>
<td>All cause and cause-specific survival calculated using Kaplan–Meier and Cox proportional hazards regression.</td>
<td>Areal measure of deprivation: quintiles of the Townsend score 1991 of the ED at diagnosis. EDs have an average population size of 500.</td>
<td>Significant impact of SES. Hazard ratio for cause-specific survival 1.12 comparing the most-affluent quintile to the three most-deprived quintiles.</td>
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<td>46</td>
<td>Yabroff KR (2003)</td>
<td>Breast</td>
<td>Part-national cancer registry data: USA (SEER data)</td>
<td>Cause-specific mortality rate</td>
<td>Areal measure of deprivation: four census variables used on median family income, percentage of high school graduates, percentage unemployed, and percentage of individuals living below the US poverty level, attributed to individual cancer patients on the basis of their county at diagnosis. The average population of a county is 90 000.</td>
<td>Five-year cause-specific mortality higher amongst the most deprived counties. Rate ratios comparing the most deprived quartile to the most affluent quartile ranged from 1.09 for median income to 1.44 for percentage of high school graduates.</td>
</tr>
</tbody>
</table>

SES, socio-economic status; NHL, non-Hodgkin’s lymphoma; SLA, statistical local area; ED, enumeration district; HR, hazard ratio; EA, enumeration area; HMO, Health Maintenance Organisation; ER, estrogen receptor; RCT, randomised controlled trial; SEER, Surveillance Epidemiology and End Results.
independent effects of ethnicity and poverty, whilst others have argued that ethnic differences in survival are simply socio-economic differences under a different guise. For this review, research examining both ethnic and socio-economic differences in survival has only been included where the findings contribute to understanding the causes of socio-economic patterns.

Studies of the association between socio-economic variables and cancer survival since 1995 have examined a number of different malignancies in a range of different settings including bladder [9, 28], breast [21, 22, 25, 32, 40–42, 46], cervix [38], large bowel [11, 44, 45], digestive tract [16, 17, 29], head and neck [30], prostate [21, 23], childhood malignancies [35], selected groups of frequent cancers [14, 18–20, 24, 26, 27, 31, 36, 39, 43], and all malignancies [8, 10, 12, 13, 33, 34, 37]. Almost all have used an ecologic measure of social deprivation to categorise patients by social status. In a minority of studies, socio-economic status has been defined instead by health insurance status [27], health care delivery system [32] or by one of several direct measures of individual wealth [11, 17, 23, 24, 33, 34, 39]. Most studies have used population-based cancer registry data to investigate these associations, but differences have also been shown to exist in other types of data including randomised controlled trials [44], cohort studies [23, 33], case–control studies [17], hospital-based data series [11, 39] and audit data [41, 42, 45]. A few studies [15, 17, 21, 22, 33, 42, 44] examined crude survival (survival from cancer and all causes of death combined) rather than disease-specific (either net or relative) survival, which can be interpreted as survival from cancer in the absence of other causes of death.

evidence for socio-economic differences

Nearly all the studies document a relationship between cancer survival and measures of social class, socio-economic status or deprivation. The impact of deprivation on cancer survival is generally moderate. Most estimates of the relative risk of death within 5 years of diagnosis in the most deprived group, compared with the most affluent group, are in the range 1.3- to 1.5-fold.

null associations

A few studies have reported no association between socio-economic status and cancer survival [8, 9, 11, 12, 15, 18–20, 22, 25, 28, 29, 35, 40]. These studies suggest that social class differences are not evident for childhood malignancies [12, 35]. Socio-economic differences are also smaller in some ecological studies. In such studies, individuals are assigned to a deprivation category derived from characteristics of the geographic area in which they live. If these geographic units are large, with heterogeneous populations, socio-economic differences in survival are less readily identifiable [8, 40, 47]. In some studies, the sample size was small [11, 15, 28]. A handful of findings are less easily explained. For example, in one group of studies, a persistent association between survival and tertiles of relative income has been demonstrated for patients residing in the USA, with the poor surviving less time than the rich, but not for Canadian patients [18–20, 22]. These findings are in contrast to a weak deprivation gap between poor and rich cancer patients demonstrated in similar Canadian data by a different group of authors [10]. Two studies from the UK dealing with survival from cancers of the bladder [9] and digestive tract [29] showed no association with deprivation, despite the fact that sufficient numbers of cases were analysed and previous work on similar data showed small but significant differences [12].

discussion

These papers leave little doubt that socio-economic status remains an important prognostic factor for most common cancers in adults, but not in children, and in many populations.

The explanations for socio-economic differences in survival are not so well documented. The possible underlying causes can be separated into three groups: factors relating to the tumour, the patient and the health care system [2]. We discuss each of these in turn.

tumour characteristics

stage at diagnosis. Many of the attempts at explaining social differences in cancer survival in the past have focused upon differences in the stage of disease at diagnosis [2]. Stage, however it is defined, certainly varies substantially between populations for which survival differences have been observed, and it has been shown to be a key explanation for international differences in survival [48], at least for breast cancer [49] and colorectal cancer [50]. Similarly, in other studies, racial differences in survival have been largely explained by stage at diagnosis [51–56].

Amongst the most recent studies focused on socio-economic differences in survival, Brewster et al. [57] report no differences between socio-economic groups in stage at diagnosis for breast, colorectal, ovarian and lung cancers, although a re-analysis of their breast cancer data by Kaffashian et al. [25] shows a significant trend of increasing tumour size with increasing deprivation. In the USA, health insurance status has been taken as a surrogate for socio-economic status. Lee-Feldstein et al. [58] showed that uninsured or publicly insured patients with breast cancer were less likely to have early-stage disease at diagnosis, and had lower survival than privately insured patients. A population-based study in Kentucky, USA, showed a similar effect of health insurance on survival from cancers of the breast, lung, bowel and prostate; the effect was reduced by adjustment for stage at diagnosis [27]. Similar results have been obtained for several other malignancies, with both ecologic and individual measures of socio-economic status [11, 16, 59–63]. Two small studies found no relationship between socio-economic status and stage [41, 45].

Variations in the stage of disease at diagnosis offer an attractive explanation for socio-economic patterns in survival, because stage is the most strongly predictive of all clinical prognostic factors [64]. For breast cancer, it is inversely related to patient delay in seeking health care [65], which is also associated with lower survival [66]. This implies that patient or health care provider delay is longer amongst individuals of lower socio-economic status. There is some suggestive evidence for the patient element of this hypothesis, such as a greater number of emergency and in-patient admissions amongst deprived
individuals for lung, colorectal and breast cancer [67], and longer reported duration of symptoms prior to diagnosis for cervical cancer [68]. In contrast, a recent systematic review did not find convincing evidence for increased patient delay among more deprived women diagnosed with breast cancer [69], nor was there any evidence of differential delay from either the patient or the provider in a small sample of bladder cancer patients [9]. One hospital-based study offers some evidence that both patient and provider delays in access to care for colorectal cancer are associated with fewer years of education. Neither stage nor education were significant predictors of crude survival in a multi-variable model, but the sample was small [11].

Overall, the idea that socio-economic differences in the stage of disease at diagnosis are the result of differential delays in diagnosis, whether by the patient or by the provider, is not supported by strong research evidence.

Other work has implied a more complex relationship between stage, socio-economic status and survival. In one population-based study, stage at diagnosis explained 28% of the differences in breast cancer survival between social class categories defined by individual occupation, but none of the difference between deprivation categories defined ecologically [25]. The authors suggest this indicates that some non-occupational aspects of poverty lead to lower survival, independently of the stage of disease at diagnosis. In population-based data for 10 common cancers in south-east England, stage explained little of the differences in survival between deprivation categories based upon area-based scores [36]. More detailed analysis of the breast cancer data showed that differences in stage at diagnosis explained part of the socio-economic gradient in survival for older women (65–99 years) but not for younger women (30–64 years) [70]. In the south-eastern Netherlands, the absence of metastasis at diagnosis explained most of the differences in survival by social class for cancers of the breast and stomach, but stage at diagnosis did not explain the observed survival differentials for cancers of the lung, large bowel or prostate [71]. Indications of the independent prognostic value of deprivation over and above differences in stage of disease are also evident from other studies [16, 17, 24].

To the extent that socio-economic differentials in cancer survival are not explained by differences in the stage of disease recorded at diagnosis, it is conceivable that they result from residual confounding by stage. Under this scenario, socio-economic differences in the quality or intensity of diagnostic investigation would lead to deprived patients having their tumours misclassified as localised—when in fact they were more advanced—more frequently than affluent patients [70]. This results in stage migration bias, also known as the 'Will Rogers' phenomenon [72]. This bias would lead to poorer stage-specific and stage-adjusted survival in deprived patients. The impact on survival differentials is likely to be small, at least for colorectal and breast cancers, since socio-economic differences in stage-specific and stage-adjusted survival are still evident in studies where stage has been independently re-classified by researchers blinded to the patient’s deprivation status [11, 28, 41, 45]. However, it remains possible that stage migration may explain part of the socio-economic variation in population-based estimates of cancer survival that cannot be quantitatively attributed to stage.

In summary, although stage of disease at diagnosis explains much of the socio-economic differentials in survival in some studies, it cannot explain all the differences, and the postulated relationship between health-seeking behaviour and stage is not supported by strong evidence of differential delay in diagnosis between socio-economic groups. Most of the recent research summarised here highlights the role of other factors in socio-economic survival gradients, suggesting that an emphasis on stage of disease alone is likely to be too simplistic if we are fully to understand these inequalities.

**biological characteristics.** Biological characteristics of the tumour itself have also been considered as explanatory factors for socio-economic differentials in survival. The morphologic type of breast cancer in women is a prognostic factor [73] that has been shown to vary by socio-economic group [74], but it has not been found to have a large impact upon socio-economic survival differences [25, 70]. Anatomic site, morphology and grade are unlikely to explain socio-economic survival differences for colon cancer [75]. Although tumour grade has been shown to influence breast cancer survival [64], only a non-significant association between socio-economic status and grade has been observed in the UK [76]. For breast cancer, estrogen receptor (ER) status has been shown to explain at least some of the socio-economic and racial differences in survival [41, 42, 77], although an association between deprivation and ER status has not always been observed [74, 78–80]. The underlying reasons for variability in ER status by socio-economic group have not been fully investigated. Variations in systemic inflammatory response, thought to be related both to smoking and to alcohol consumption, were considered as a potential explanation for socio-economic differences in survival in patients with colon cancer undergoing curative resection, but found to be non-significant [81]. There is limited evidence from a small population-based study in Scotland that later stage at diagnosis of cervical cancer is associated more strongly with faster tumour cell proliferation than with delay in diagnosis, and that cell proliferation may be faster in deprived patients. The authors speculate that lifestyle factors could influence tumour biology; this question needs further research [68].

**patient characteristics**

**host factors and the effect of treatment.** Use of relative survival as an outcome measure in population-based studies of cancer patient survival compensates for overall background mortality in the cancer patient group [82]. Co-morbidity (the presence of other chronic conditions) may reduce survival from cancer over and above the impact that such conditions have on overall mortality, however, by interacting with the treatment given for cancer [83]. In studies that make no correction for background mortality, co-morbidity has been found to predict survival [54, 84]. In a population-based study in The Netherlands, co-morbid conditions were more common in deprived patients with cancers of the breast and lung, but not in patients with stomach or prostate cancer [85]. In the only study we could find that examined the presence of other diseases in relation to cancer-specific survival, co-morbidity increased the risk of death from
bowl cancer, but did not vary by socio-economic status [86]. This study of 483 consecutive patients in a large regional centre was not population-based. There is evidence that smoking amongst cancer patients varies with deprivation status [9]. Such differentials in high-risk behaviours may also lead to poorer health status amongst deprived patients that are not evident in quantifiable co-morbidity scores but which nevertheless have an impact upon patient survival. However, in the one study that controlled for smoking and alcohol consumption prior to cancer diagnosis, the impact of these health behaviours upon crude survival was small, both for respiratory-related malignancies and all cancers combined [33]. Further research is needed on the extent to which socio-economic gradients in cancer survival may be confounded by co-morbidity and health behaviours.

Similarly, it has been postulated that better nutrition amongst the affluent may also influence a person’s ability to withstand treatment, above and beyond the differentials in background mortality accounted for with disease-specific or relative survival [2]. Little work has been done in this area. It has been shown that obesity, more prevalent amongst deprived women [87], is inversely associated with survival for localised breast cancer [88, 89]. However, nutritional measures appear to have little impact upon survival from laryngeal cancer [90]. Possible confounding of socio-economic differences in survival by nutrition or body composition has not yet been explicitly examined.

**Psychosocial factors.** Some evidence suggests that social support leads to better overall survival. Married individuals have been found to have significantly better survival in some studies [23, 24, 56, 61], possibly because increased social support leads to appropriate diagnosis and treatment being sought in a more timely fashion [69]. Social support in the 3 months after surgery for non-metastatic breast cancer was non-significantly associated with improved survival in one small study [91]. Such factors are probably most influential in the earliest stages of the disease and for young patients [92]. Social support is less frequent amongst low-income or disadvantaged groups, and if such factors have any impact on survival, they could contribute to socio-economic differentials [93].

A recent study highlighted the importance of other socially influenced factors, including poor or unclear access to medical services, the social stigma attached to cancer and the associated delay in seeking health care, individual perceptions of personal risk, inappropriate health promotion strategies and poor communication with health care professionals [94]. Other research has shown that women from lower socio-economic groups are able to identify significantly fewer symptoms of breast cancer [95] and that breast cancer patients living in affluent areas are more likely to have received information on their disease from a hospital specialist, and less likely to have concerns about money, other health problems and family issues [93]. In a hospital-based study of 578 women with early breast cancer, high scores on depression, ‘helplessness’ or ‘hopelessness’, derived from survey instruments that reflect the psychological health of cancer patients, were found to have a negative impact on relapse and crude 5-year survival [96].

**Health care factors.**

**Treatment received.** There is increasing evidence of different treatment being given to cancer patients in different socio-economic groups. For example, linkage of hospital discharge records with population-based cancer registry data in Washington State, USA, showed that adjuvant chemo- or radiotherapy following surgery for stage II or III colon cancer, recommended by national guidelines, was significantly less likely to be given to patients aged over 65 years, to those in the poorest quartile of zip (postal) code areas and to those insured by Medicare compared with those with private insurance, none of which are specified by the guidelines as criteria for treatment [97]. Affluent patients in south-east England have been shown to be more likely to receive surgery for lung, colorectal and breast cancer [67]. Differences between socio-economic groups in follow-up after an abnormal mammogram for breast cancer and in post-treatment care for colorectal cancer have also been suggested as explanations for differences in survival where treatment with curative intent is available [46, 98]. Despite universal, comprehensive health insurance coverage and a centrally organised radiotherapy service in Ontario, Canada, elderly or poor women with breast cancer were significantly less likely to receive radiotherapy within a year of diagnosis. This suggests a degree of ‘implicit’ rationing with respect to age and income [99]. Women with breast cancer living in deprived areas have been found to be more likely to receive a mastectomy than breast-conserving therapy in comparison with those living in affluent places in both the UK [41, 74, 100] and the USA [101]. Variation in mastectomy rates between screening centres in one region of England was not accounted for by differences in tumour size, site, grade, patient age or year of presentation [102]. However, since survival after mastectomy and breast conserving surgery is similar [103], such differences seem unlikely to explain socio-economic inequalities in survival unless there is also differential access to radiotherapy or systemic treatment between socio-economic groups.

It has been suggested that differences in treatment largely explain socio-economic differences in cancer survival in the USA [104], and either most [105] or all [106–108] of the observable racial differences. These studies examined both data from clinical trials, in which treatment was equalised within each trial arm, and information from population-based settings in which all patients received an equal level of care. The explanatory power of unequal treatment for racial differences in survival is particularly striking, since the alternative explanation is that differences in survival between ethnic groups are attributable to genetic factors; this cannot apply to socio-economic variability in survival within ethnically homogeneous populations. It has been suggested that breast carcinoma is more aggressive in African-American than Caucasian women, since onset is substantially younger and more aggressive in the former group [60, 109, 110]. If the conclusion from these studies, that ‘equal treatment yields equal outcome, . . . regardless of race’ [108], is valid despite possible differences in the biological spectrum of tumours, it follows that ensuring equal access to treatment could be at least as important in eliminating differences in survival between groups that are defined solely by social characteristics.
Research in other countries has not identified such clear distinctions in survival with respect to treatment. For women with breast cancer in Glasgow, Scotland, patterns of treatment and care were similar for affluent and deprived groups, as defined by their area of residence, although deprived women consulted more frequently for other conditions, suggesting much higher co-morbidity [59]. In a population-based study in California, USA, the likelihood of younger women with breast cancer receiving breast-conserving therapy did not differ by health insurance category, but varied by type of hospital [58]. However, in South Australia, survival after breast cancer was not associated with the hospital attended [111].

medical expertise. The expertise or experience of the treating physicians could also differ between socio-economic groups. In one population-based study in Calvados, France, unemployed colorectal patients were half as likely as more affluent patients to be seen by a gastroenterologist or to be treated in a specialised centre, although these patterns did not explain all the survival differences [112]. In a population-based study of over 75 000 patients with cancer of the breast, bowel or lung in the UK, linkage to hospital admission data showed that patients living in deprived areas were admitted more often as emergencies. Deprived patients with breast or lung cancer were also less likely to be recorded as having had surgery, and bowel cancer patients were less likely to be treated in a centre with a large caseload, although the opposite was true for women with breast cancer [67].

Women with breast cancer treated by specialist surgeons in Scotland had higher survival than other women, regardless of the level of deprivation [113]. However, specialised surgeons have been shown to treat higher proportions of both affluent and deprived women than non-specialists [114, 115], a finding supported by data on colorectal cancer [45]. Consequently, local variations in the extent to which patients are managed by specialists may account for some differentials in survival, but there is little evidence to suggest that this can account for deprivation gradients in survival.

The availability of doctors in the USA, used as a crude measure of health care quality, appears to improve the early detection of tumours [116], but not survival [61]. Initial treatment at hospitals with a high caseload [45] or at a teaching hospital [117] has been shown to have a positive impact on survival in the UK and Canada. It is not clear, however, that individuals with low socio-economic status are less likely to be attended in teaching or high-volume hospitals [118]. Consequently, these patterns appear unlikely to explain socio-economic differences in survival.

screening. Low uptake of mammography among groups of lower socio-economic status may lead to socio-economic differentials in the stage of disease at diagnosis and in survival, even though screening is similarly effective in all socio-economic groups [119, 120]. In a clinical trial of screening for colorectal cancer in the UK, compliance was shown to be associated with earlier diagnosis and longer post-operative survival. Deprived subjects were less likely to accept the invitation to be screened [44], but after adjustment for age and participation in screening, the impact of deprivation on survival was only evident for women. Further work on the confounding of socio-economic differentials in survival by participation in screening will be required in order to confirm this finding and, in particular, to quantify the impact on survival of differential participation in screening between socio-economic groups.

conclusions

An association between cancer survival and measures of socio-economic status has been observed for many different cancers, in several different clinical and geographic settings, and with various definitions of social position. This pattern is not confined to cancer survival. Similar differences have been observed in mortality from stroke in Canada [121] and from cardio-vascular disease in the UK [122], despite evidence that socio-economic status was not associated with differences in appropriate treatment [123]. Differences between socio-economic groups in the stage of disease at diagnosis and in access to optimal treatment clearly explain at least part of the association between social deprivation and cancer survival. It seems unlikely, however, that differences in the expertise of medical personnel involved in treating patients in different social groups explains much of the survival differentials. The impact on disease stage, and on survival, of delay in seeking health care (patient delay) and delay in referral for diagnosis and specialist care (system delay) is also unclear. This requires further research. Characteristics of the patient, such as nutrition, co-morbidity and health-seeking behaviours, may also interact with treatment decisions and, ultimately, with the outcome. These characteristics have received little attention. It is important to find out whether socio-economic differences in how patients seek and obtain access to health services, or participate in screening, are associated with socio-economic differences in cancer survival.

references


