Socioeconomic background in relation to stage at diagnosis, treatment and survival in women with breast cancer

In a large population-based series of invasive breast cancer patients, we investigated socioeconomic background (SEB) in relation to (a) stage at diagnosis; (b) treatment pattern; and (c) 5-year survival. Women diagnosed during 1998–2000 and resident in the Northern and Yorkshire regions of England were identified from the cancer registry database (N = 12,768). Logistic regression and Cox proportional hazards analyses were used to estimate associations between SEB (defined using the Townsend Index for area of residence) and tumour stage, treatment pattern, and survival. Living in a more deprived area was associated with increased likelihood of being diagnosed with stage III or IV disease (age-adjusted odds ratio (OR) 1.13; 95% confidence interval (CI) 1.08–1.18 per quartile increase in Townsend score), and, after adjustment for age and stage, reduced odds of having surgery (OR 0.85; 95% CI 0.80–0.91), and receiving radiotherapy (OR 0.91; 95% CI 0.88–0.94). Amongst patients receiving surgery, those living in more deprived areas had decreased odds of having breast conserving surgery (age plus stage-adjusted OR 0.92; 95% CI 0.89–0.95). Living in a more deprived area was also associated with increased mortality (age-plus stage-adjusted hazard ratio 1.08; 95% CI 1.05–1.11). These effects may operate through several pathways, such as later presentation leading to advanced disease.

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MATERIALS AND METHODS

Women with invasive breast cancer (ICD10; World Health Organisation, 1992; code C50) diagnosed in the years 1998–2000 and resident in the Northern and Yorkshire regions were identified from the Northern and Yorkshire Cancer Registry and Information Service database. Patient age and tumour stage at diagnosis (using the TNM system; Singletry et al, 2002), treatment (type of surgery and whether or not radiotherapy (RT), chemotherapy (CT), or hormone therapy (HT) were given), the time taken to receive a hospital appointment after GP referral (appointment delay), and the time taken to receive treatment after diagnosis (treatment delay) were extracted. SEB was defined at the 1991 enumeration district level of residence using the Townsend index (Townsend
and Phillimore, 1988) and matched to the patient using their postcode. An area deprivation score could not be obtained in 40 cases.

All factors were examined in relation to quartiles of area deprivation (Townsend score) (Table 1). Logistic regression analyses were used to examine any associations between SEB and stage or treatment (type of surgery, use of adjuvant treatments, appointment delay and treatment delay), whereas Cox proportional hazards analyses (Cox, 1972) were used to evaluate any association between SEB and 5-year survival. Models were adjusted for age or age plus stage. Proportionality assumptions were verified for all survival models.

The Townsend score was scaled and included as a continuous variable such that the resulting odds ratios (ORs) or hazard ratios (HRs) represent a change in the outcome per quartile increase in the Townsend score. As details of some factors were not available for all patients (Table 1), analyses were conducted after the exclusion of ‘unknowns’ for the factor under investigation.

**RESULTS**

A total of 12 768 patients were included in the analyses. A higher proportion of patients living in the most deprived quartile (45.3%; 95% confidence interval (CI) 43.6–47.0) were older than 65 years at diagnosis compared to those living in the most affluent quartile (35.9%; 95% CI 34.2–37.6) (Table 1). Patients living in the most affluent quartile were diagnosed more frequently with stage I

| Variable                      | All patients | Townsend quartile |
|-------------------------------|--------------|-------------------|
| Age                           | N (%)        | I (affluent)      | II   | III  | IV (deprived) |
| <50                           | 2698 (21.1)  | 696 (21.8)        | 706  | 657  | 639 (20.0)   |
| 50–64                         | 4812 (37.7)  | 1354 (42.3)       | 1254 | 1097 | 1107 (34.7)  |
| 65+                           | 5258 (41.2)  | 1148 (35.9)       | 1227 | 1438 | 1446 (45.3)  |
| Stage                         |              |                   |      |      |               |
| I                             | 4539 (39.2)  | 1235 (42.0)       | 1202 | 1063 | 1039 (36.1)  |
| II                            | 5576 (48.1)  | 1380 (47.0)       | 1414 | 1416 | 1366 (47.8)  |
| III                           | 900 (7.8)    | 210 (7.1)         | 220  | 217  | 253 (8.8)    |
| IV                            | 578 (5.0)    | 114 (3.9)         | 110  | 153  | 201 (7.0)    |
| Surgery                       |              |                   |      |      |               |
| BCS alone                     | 4605 (36.2)  | 1288 (40.4)       | 1250 | 1058 | 1009 (31.7)  |
| Mastectomy alone              | 4721 (37.1)  | 1146 (36.0)       | 1141 | 1201 | 1233 (38.8)  |
| BCS and mastectomya           | 1178 (9.3)   | 332 (10.4)        | 319  | 293  | 234 (7.4)    |
| No surgery                    | 2217 (17.4)  | 421 (13.2)        | 464  | 627  | 705 (22.2)   |
| Radiotherapy                  |              |                   |      |      |               |
| Yes                           | 6734 (53.6)  | 1831 (58.3)       | 1755 | 1602 | 1546 (49.0)  |
| No                            | 5837 (46.4)  | 1309 (41.7)       | 1371 | 1548 | 1609 (51.0)  |
| Surgery and RTb               |              |                   |      |      |               |
| BCS alone                     | 3951 (86.6)  | 1123 (88.2)       | 1068 | 894  | 866 (86.3)   |
| Mastectomy alone              | 2079 (44.8)  | 524 (46.8)        | 517  | 525  | 513 (42.2)   |
| BCS and mastectomya           | 396 (34.3)   | 120 (37.5)        | 109  | 100  | 67 (28.9)    |
| No surgery                    | 304 (13.7)   | 61 (13.2)         | 81   | 100  | 100 (14.2)   |
| Hormone therapy               |              |                   |      |      |               |
| Yes                           | 10285 (81.2) | 2540 (80.4)       | 2535 | 2605 | 2605 (82.1)  |
| No                            | 2376 (18.8)  | 621 (19.6)        | 618  | 568  | 569 (17.9)   |
| Chemotherapy                  |              |                   |      |      |               |
| Yes                           | 3536 (28.1)  | 917 (29.2)        | 898  | 888  | 833 (26.4)   |
| No                            | 9036 (71.9)  | 2223 (70.8)       | 2231 | 2262 | 2230 (73.6)  |
| Appointments delay            |              |                   |      |      |               |
| 0–14 days                     | 5290 (60.7)  | 1302 (62.7)       | 1258 | 1397 | 1333 (58.6)  |
| 15–28 days                    | 2051 (23.3)  | 483 (23.2)        | 489  | 516  | 563 (24.8)   |
| 29–60 days                    | 1028 (11.8)  | 219 (10.5)        | 250  | 273  | 286 (12.6)   |
| 61–180 days                   | 351 (4.0)    | 74 (3.6)          | 95   | 90   | 92 (4.0)     |
| Treatment delay               |              |                   |      |      |               |
| 0–14 days                     | 7461 (60.2)  | 1932 (61.9)       | 1845 | 1855 | 1829 (59.3)  |
| 15–28 days                    | 3442 (27.8)  | 842 (27.0)        | 881  | 844  | 875 (28.4)   |
| 29–60 days                    | 1342 (10.8)  | 317 (10.2)        | 335  | 350  | 340 (11.0)   |
| 61–180 days                   | 141 (1.1)    | 28 (0.9)          | 33   | 38   | 42 (1.4)     |

BSC = breast conserving surgery; RT = radiotherapy. Number of cases excluded from each variable owing to unknown status is as follows: stage; 1175 cases, surgery allocation; 47 cases, radiotherapy; 197 cases, hormone therapy; 107 cases, chemotherapy; 196 cases, appointment delay; 4048 cases, treatment delay; 382 cases. bBCS before mastectomy. 

ªProportion of patients that received RT, by type of surgery.
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95% CI 80.7 – 83.4 respectively) nor in the proportions receiving HT (82.1%; 95% CI 80.4 – 83.6) vs RT (86.3%; 95% CI 84.2 – 88.5 and 88.2%; 95% CI 6.4 – 8.3), a greater proportion of those living in the most deprived quartile received no surgery (22.2%; 95% CI 20.7 – 23.6 vs 13.2% ; 95% CI 12.0 – 14.4). A higher proportion of the patients resident in the most affluent quartile received RT (58.3%; 95% CI 56.6 – 60.0) compared to those in the most deprived quartile (49.0%; 95% CI 47.3 – 50.7). There was no statistically significant difference in the proportion of patients having BCS with subsequent RT (86.3%; 95% CI 84.2 – 88.5 and 88.2%; 95% CI 86.4 – 90.0 in the most deprived and most affluent quartiles respectively) nor in the proportions receiving HT (82.1%; 95% CI 80.7 – 83.4 vs 80.4%; 95% CI 79.0 – 81.7) and CT (26.4%; 95% CI 24.9 – 28.0 vs 29.2%; 95% CI 27.6 – 30.8). Women living in the most affluent quartile were more frequently seen within 14 days of referral (62.7%; 95% CI 60.6 – 64.7) compared to those in the most deprived quartile (58.6%; 95% CI 56.6 – 60.6) but this difference was less for beginning treatment within 14 days of being diagnosed (61.9%; 95% CI 60.2 – 63.6 vs 59.3%; 95% CI 57.5 – 61.0).

The logistic regression analyses show that, after adjustment for age, living in a more deprived area was associated with a significantly increased odds of being diagnosed with stage III or IV disease (OR 1.13; 95% CI 1.08 – 1.18 per quartile increase in Townsend score) (Table 2). After adjustment for age and stage, living in a more deprived area was significantly associated with decreased odds of receiving surgery (OR 0.85; 95% CI 0.80 – 0.91) and RT (OR 0.91; 95% CI 0.88 – 0.94). Amongst patients receiving surgery, living in a more deprived area was associated with significantly decreased odds of having BCS (OR 0.92; 95% CI 0.89 – 0.95 per quartile increase), and significantly increased odds of having a mastectomy (OR 1.08; 95% CI 1.05 – 1.12). Area Townsend score was not significantly associated with the odds of CT (OR 0.97; 95% CI 0.93 – 1.01), although the association was of borderline significance for HT (OR 1.04; 95% CI 1.00 – 1.08). Living in a more deprived area was also associated with an appointment delay of more than 14 days (OR 1.07; 95% CI 1.03 – 1.11) and a treatment delay of more than 14 days (OR 1.05; 95% CI 1.02 – 1.08). The age plus stage-adjusted results differed little from the age-adjusted results, and only in the case of treatment delay did the estimate become statistically significant after additional adjustment for stage.

Following age adjustment, living in a more deprived area was associated with an increased risk of death (HR 1.11; 95% CI 1.08 – 1.13 per quartile increase in Townsend score), which was reduced after adjusting for stage (HR 1.08; 95% CI 1.05 – 1.11) (Table 3). When these analyses were repeated separately for patients undergoing BCS, having a mastectomy and having no surgery, there was a stronger association between Townsend score and survival for the BCS group (age plus stage-adjusted HR 1.13; 95% CI 1.07 – 1.19 per quartile increase) than for the mastectomy group (HR 1.04; 95% CI 1.00 – 1.08) and the no surgery group (HR 1.03; 95% CI 0.98 – 1.08); these results differed little from the age-adjusted results.

**DISCUSSION**

Our results show that patients living in more deprived areas were more likely to be diagnosed with more advanced (stage III or IV) disease. This may be related to later presentation and lower rates of mammography screening in lower SEB areas. This finding contrasts with those of several other studies (Brewster et al, 2001; Thomson et al, 2001; Taylor and Cheng, 2003). However, this study was based on a much larger number of patients and staging data were available in over 90% of cases.

Women living in more deprived areas were less likely to have surgical treatment than those in affluent areas, and when they had surgery they were more likely to have a mastectomy. Adjustment for stage of disease at diagnosis made little difference to these results. Decisions about whether or not patients receive surgery and the type of surgery performed are the outcome of, in many cases, a complex interaction between stage and evaluation of the choices offered to patients by their clinical management team, the manner in which these choices are presented, and perceptions of the risks and benefits involved. The extent to which the latter factors may vary by SEB is poorly understood.

RT was the only adjuvant treatment found to be significantly related to SEB, with women in more deprived areas being less likely to receive this. RT for breast cancer can be intensive, involving visits to a RT centre for several days each week over several weeks, and this may have more impact on the treatment decisions of women in socially deprived areas. Other UK studies have found no difference in the uptake of RT by SEB (Macleod et al, 2000b; Thomson et al, 2001). When analysis was restricted to BCS patients, there was no significant difference in RT by SEB. BCS followed by RT is considered an optimal treatment and it is

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**Table 2** Association between socioeconomic status and patient and treatment factors (Odds Ratios per quartile increase in Townsend score)

|                | Unadjusted OR (95% CI) | Age-adjusted OR (95% CI) | Age-and stage-adjusted OR (95% CI) |
|----------------|------------------------|--------------------------|-----------------------------------|
| Age <64 years  | 1.13 (1.10 –1.16)      |                          |                                   |
| Stage III/IV   | 1.14 (1.10 –1.19)      | 1.13 (1.08 –1.18)        |                                   |
| Surgical treatment | 0.82 (0.79 –0.85)   | 0.83 (0.80 –0.87)        | 0.85 (0.80 –0.91)                 |
| Breast conserving surgery | 0.89 (0.87 –0.92) | 0.92 (0.89 –0.95)        | 0.92 (0.89 –0.95)                 |
| Mastectomy     | 1.09 (1.06 –1.12)      | 1.09 (1.06 –1.12)        | 1.08 (1.05 –1.12)                 |
| Radiotherapy   | 0.88 (0.86 –0.91)      | 0.90 (0.88 –0.93)        | 0.91 (0.88 –0.94)                 |
| BCS and        | 0.95 (0.90 –1.02)      | 0.96 (0.89 –1.02)        | 0.97 (0.90 –1.03)                 |
| Radiotherapy²  | 0.96 (0.93 –0.99)      | 1.01 (0.97 –1.04)        | 0.97 (0.93 –1.01)                 |
| Chemotherapy   | 1.04 (1.00 –1.08)      | 1.02 (0.99 –1.06)        | 1.04 (1.00 –1.08)                 |
| Hormone therapy| 1.06 (1.02 –1.09)      | 1.06 (1.03 –1.10)        | 1.07 (1.03 –1.11)                 |
| Appointment delay > 14 days | 1.02 (1.00 –1.05) | 1.03 (1.00 –1.06)        | 1.05 (1.02 –1.08)                 |

BCS = breast-conserving surgery; CI = confidence interval; OR = odds ratio. *Analysis includes surgery patients only; *²Analysis includes BCS patients only.

**Table 3** Association between socioeconomic status and 5-year survival from breast cancer for all patients and by type of surgery

|                | Unadjusted HR (95% CI) | Age-adjusted HR (95% CI) | Age-and stage-adjusted HR (95% CI) |
|----------------|------------------------|--------------------------|-----------------------------------|
| All patients   | 1.14 (1.11 –1.16)      | 1.11 (1.08 –1.13)        | 1.08 (1.05 –1.11)                 |
| Breast-conserving surgery group | 1.13 (1.07 –1.19) | 1.14 (1.08 –1.20)        | 1.13 (1.07 –1.19)                 |
| Mastectomy group | 1.05 (1.01 –1.09) | 1.04 (1.00 –1.08)        | 1.04 (1.00 –1.08)                 |
| No surgery group | 1.04 (1.00 –1.08) | 1.04 (1.00 –1.08)        | 1.03 (0.98 –1.08)                 |

CI = confidence interval; HR = hazard ratio.
reassuring that there were no differences in this by SEB. Previous results on CT and HT have been inconclusive, with some studies reporting an association with SEB (Thomson et al, 2001; Taylor and Cheng, 2003) and others not (Macleod et al, 2000b; Taylor and Cheng, 2003). In our study, there was no association between Townsend score and CT, but there was a weak borderline significant association with HT. The decision to give adjuvant therapies is complex and depends upon such factors as whether the patient has undergone surgery and the ER status of the tumour, making it difficult to draw any firm conclusions from these results.

Current guidelines state that women should not wait longer than 14 days between GP referral and a first hospital appointment or between diagnosis and beginning treatment (National Institute for Clinical Excellence, 2002). During our study period, these targets were met in approximately 60% of cases. Women living in more deprived areas were more likely to wait more than 14 days for a hospital appointment than those in more affluent areas, though these results are limited by the fact that data were missing in 32% of cases. A weaker association between SEB and treatment delay was also apparent, which could indicate an influence of SEB on management. Nevertheless, although long delays by the patient are associated with decreased survival (Richards et al, 1999), delays by providers have not previously been linked to poorer outcomes (Sainsbury et al, 1999).

Living in a more deprived area was associated with lower 5-year survival. The age-adjusted HR was 1.11 (95% CI 1.08–1.13) per quartile increase in Townsend score and this reduced to 1.08 (95% CI 1.05–1.11) when additionally adjusted for stage. A previous study found that adjusting for stage did not substantially change the estimated HRs for deprivation category (Kaffashian et al, 2003). One explanation for this is that the adjustment for stage is insufficient because stage is not a sensitive enough measure to capture the variation in disease. For example, stage IV patients could present with early metastatic spread or may have such advanced disease that no treatment, other than palliative care, can be given. Stage therefore fails to act as an adequate proxy for preceding confounders associated with severity of disease.

Several other studies have concluded that prognostic factors, such as tumour stage, grade, size, and lymph node status only partly account for the differences in survival by SEB (Cannon et al, 1994; Macleod et al, 2000a; Brewster et al, 2001). Another factor associated with SEB is ER status, with patients living in more deprived areas having higher levels of ER negative tumours (Twelves et al, 1998; Thomson et al, 2001; Taylor and Cheng, 2003). It has been reported that these tumours appear to have a worse prognosis, though the difference in ER status was estimated to be 20% (Thomson et al, 2000a; Brewster et al, 2001). It has been reported that these tumours may act as an intermediate end point. This figure suggests that the true public health effect of SEB on survival is that of the age-adjusted estimate. Alternatively, one might make use of stage lying on the causal path, as it is then a candidate for an intermediate end point (Freedman et al, 1992), that is, a marker or event that is assessed before the outcome (survival in this case), and sufficiently associated with the outcome that it acts as its proxy. From this perspective, the age- plus stage-adjusted model yields estimates of the joint effect of SEB and stage on survival. Using Freedman’s method, it can be estimated how much of the SEB effect on survival is mediated via the influence of SEB on stage (26% using the age-adjusted estimate as the denominator). This figure suggests that stage is not an ideal choice of intermediate end point, though this might be in part owing to measurement error and missing data associated with stage. Whether stage is considered as a proxy for preceding confounders and/or an intermediate end point, it seems poor in both respects.

This study used an area-based measure of SEB, as an individual measure is not available from cancer registry data. Owing to the ecological fallacy (Robinson, 1950), these results cannot be extended to individual women living in each area. We are exploring alternative methodologies to address both the ecological problem and potentially biased adjustment for confounders that lie on the causal path betwen SEB and survival.

This study has shown that breast cancer patients living in more deprived areas were more likely to be diagnosed with later stage disease than those in more affluent areas and that there were significant differences in the type of treatment received. Living in a more deprived area was associated with decreased survival, perhaps owing to later presentation and more complex treatment decisions. Part of this survival gap may be reduced through policies to encourage earlier diagnosis and appropriate treatment uptake, but the association between SEB and other factors, such as comorbidity, requires further investigation.

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