

LETTER TO THE EDITOR

## Neighborhood Deprivation and Mortality in Women with Breast Cancer: A Multilevel Analysis From Sweden

To the Editor:

Previous research has shown associations between individual-level socioeconomic status and education and breast cancer risk and survival (1–4). Studies have also linked neighborhood socioeconomic status to health status (5) and mortality (6). To the best of our knowledge, however, no study has examined whether level of neighborhood deprivation affects mortality in women with breast cancer.

In the present study, we performed multilevel analysis to analyze whether or not level of neighborhood deprivation affected mortality in women in Sweden diagnosed with breast cancer. A second aim was to ascertain whether or not the hypothesized effect remained after accounting for individual-level variables.

Data used in this study were retrieved from the MigMed 2 data base maintained at the Center for Primary Health Care Research, Lund University, Malmö, Sweden. MigMed 2 was constructed by linking several national Swedish data registers, including, but not limited to, the Total Population Register, the Multi-Generation Register, the Swedish Cancer Registry, and the Cause of Death Register. Information from the various registers in the data base is linked at the individual level via the national 10-digit personal identification number assigned to each resident in Sweden for his or her lifetime. Prior to inclusion in the MigMed 2 data base, these personal identification numbers were replaced by serial numbers to preserve anonymity.

The study population consisted of all women in Sweden aged 30–64 years, and the study period was from 1 January 1990 to 31 December 2005. The outcome variable was mortality in women with breast cancer. Only cases classified according to the seventh

revision of the International Classification of Diseases as primary neoplasms of the breast (code 170) were included in the study. We used income data from 1990 from the Swedish Total Population Register to assess level of neighborhood deprivation (7).

Information on tumor stage at diagnosis is not available in MigMed 2. Type of tumor—in situ or invasive—was used as a proxy for tumor stage at diagnosis. We undertook a secondary analysis of risk of mortality by level of neighborhood deprivation in women diagnosed with in situ breast cancer.

Multilevel logistic modeling (8,9) was used to estimate the proportion of women with breast cancer, who died during the study period. We created three models: model 1 was the empty or unconditional model; model 2 included the neighborhood-level variable (level of neighborhood deprivation by quartile); and model 3 included the neighborhood-level variable and the individual-level variables age, marital status, immigration status, region of residence, family income, educational attainment, and employment status. Fixed effects are presented as odds ratios (ORs) with 95% confidence intervals (CIs).

Between-neighborhood variance in mortality in breast cancer patients ( $V_{\text{between-neighborhood}}$ ) was estimated (7,10,11) and the proportion of the between-neighborhood variance explained by the different variables ( $V_{\text{explained}}$ ) then calculated using the following formula:

$$V_{\text{explained}} = (V_{\text{between-neighborhood in model 1}} - V_{\text{between-neighborhood in model 2 or 3}}) / V_{\text{between-neighborhood in model 1}}$$

A total of 55,723 women in Sweden were diagnosed with breast cancer between 1990 and 2005 (data not shown), 16.5% of whom died during the study period. Age-adjusted mortality in women with breast cancer increased with increasing level of neighborhood deprivation. Overall, the mortality rate was 137.4 per 1,000 in the least deprived neighborhoods (quartile 1), 167.8 per 1,000 in moderately deprived neighborhoods (quartiles 2 and 3), and 191.2 per

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1,000 in the most deprived neighborhoods (quartile 4). Mortality was higher in more deprived neighborhoods in women in all individual-level variable categories.

Logistic regression analysis showed that the risk of mortality in women with breast cancer increased as

**Table 1. ORs and 95% CIs for Mortality in Breast Cancer Patients: Results From Multilevel Logistic Regression Analysis**

|                                                                                                    | Model 2<br>(neighborhood-level<br>variable included) |        |      | Model 3 (full model) |        |      |             |
|----------------------------------------------------------------------------------------------------|------------------------------------------------------|--------|------|----------------------|--------|------|-------------|
|                                                                                                    | OR                                                   | 95% CI |      | OR                   | 95% CI |      | p-<br>value |
|                                                                                                    |                                                      |        |      |                      |        |      |             |
| Neighborhood-level variable: deprivation                                                           |                                                      |        |      |                      |        |      |             |
| Quartile 1<br>(least deprived)                                                                     | 1                                                    |        |      | 1                    |        |      |             |
| Quartiles 2 + 3                                                                                    | 1.27                                                 | 1.20   | 1.34 | 1.12                 | 1.05   | 1.19 | <0.001      |
| Quartile 4<br>(most deprived)                                                                      | 1.48                                                 | 1.39   | 1.58 | 1.22                 | 1.14   | 1.31 | <0.001      |
| Age (years)                                                                                        |                                                      |        |      |                      |        |      |             |
| 30–39                                                                                              |                                                      |        |      | 1                    |        |      |             |
| 40–49                                                                                              |                                                      |        |      | 1.17                 | 1.08   | 1.26 | <0.001      |
| 50–59                                                                                              |                                                      |        |      | 1.44                 | 1.33   | 1.55 | <0.001      |
| 60–64                                                                                              |                                                      |        |      | 1.99                 | 1.82   | 2.17 | <0.001      |
| Marital status                                                                                     |                                                      |        |      |                      |        |      |             |
| Married/cohabiting                                                                                 |                                                      |        |      | 1                    |        |      |             |
| Single                                                                                             |                                                      |        |      | 1.25                 | 1.19   | 1.31 | <0.001      |
| Family income                                                                                      |                                                      |        |      |                      |        |      |             |
| High                                                                                               |                                                      |        |      | 1                    |        |      |             |
| Middle                                                                                             |                                                      |        |      | 1.11                 | 1.05   | 1.18 | <0.001      |
| Low                                                                                                |                                                      |        |      | 1.13                 | 1.05   | 1.22 | 0.001       |
| Educational attainment                                                                             |                                                      |        |      |                      |        |      |             |
| Compulsory<br>schooling or less<br>(≤ 9 years)                                                     |                                                      |        |      | 1.24                 | 1.17   | 1.31 | <0.001      |
| Practical high school<br>education or some<br>theoretical high<br>schooleducation<br>(10–11 years) |                                                      |        |      | 1.11                 | 1.03   | 1.18 | 0.003       |
| Theoretical high school<br>and/or college<br>education<br>(≥ 12 years)                             |                                                      |        |      | 1                    |        |      |             |
| Immigrant status                                                                                   |                                                      |        |      |                      |        |      |             |
| Born in Sweden                                                                                     |                                                      |        |      | 1                    |        |      |             |
| Immigrated from<br>Finland                                                                         |                                                      |        |      | 0.92                 | 0.83   | 1.03 | 0.162       |
| Immigrated from a<br>country other than<br>Finland                                                 |                                                      |        |      | 0.98                 | 0.89   | 1.07 | 0.617       |
| Region of residence                                                                                |                                                      |        |      |                      |        |      |             |
| Large city                                                                                         |                                                      |        |      | 1                    |        |      |             |
| Northern Sweden                                                                                    |                                                      |        |      | 1.12                 | 1.04   | 1.19 | 0.002       |
| Southern Sweden                                                                                    |                                                      |        |      | 0.99                 | 0.94   | 1.04 | 0.617       |
| Employment status                                                                                  |                                                      |        |      |                      |        |      |             |
| Unemployed                                                                                         |                                                      |        |      | 1                    |        |      |             |
| Employed                                                                                           |                                                      |        |      | 1.40                 | 1.32   | 1.49 | <0.001      |
| Explained variance (%)                                                                             | 53                                                   |        |      | 82                   |        |      |             |

Study group: all women in Sweden aged 30–64 years.  
Study period: From 1 January 1990 to 31 December 2005.  
OR, odds ratio; CI, confidence interval.

the level of neighborhood deprivation increased (Table 1). Women with breast cancer who lived in the most deprived neighborhoods exhibited a 22% higher risk of mortality (OR = 1.22, 95% CI = 1.14 – 1.31) than those who lived in the least deprived neighborhoods, after adjustment for all individual-level variable categories (full model). Women with breast cancer who were older, single, had lower family incomes, had lower educational attainment were from Northern Sweden or were unemployed had the highest odds of mortality.

The proportion of variance explained increased after stepwise inclusion of the neighborhood- and individual-level variables, reaching 82% in the full model. This indicates that the neighborhood- and individual-level variables we analyzed explained 82% of the variance between neighborhoods.

A secondary analysis of risk of mortality by level of neighborhood deprivation in women whose primary diagnosis was in situ breast cancer showed no significant neighborhood-level effects (data not shown). Thus, it appears that level of neighborhood deprivation only predicts risk of mortality in women whose tumors were invasive at the time of diagnosis.

The findings of this study are in agreement with previous reports of associations between individual-level characteristics and breast cancer mortality. These previous studies showed that low individual income (12) and low individual-level socioeconomic status (2,13) increase the risk of breast cancer mortality. Our study further suggests that level of neighborhood deprivation is an important predictor of breast cancer mortality beyond individual characteristics.

Women who are exposed to both individual- and neighborhood-level risk factors appear to be at the highest risk of breast cancer mortality. This finding has important clinical implications, and indicates that both individual- and neighborhood-level approaches are important when developing health care policies.

## ETHICAL CONSIDERATIONS

The study was approved by the ethics committee of Lund University.

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## CONFLICT OF INTEREST

We declare that we have no conflicts of interest.

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