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Treatment and survival disparities in lung cancer: The effect of social environment and place of residence

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ABSTRACT

Objective: The purpose of this study was to measure the extent to which geographic residency status and the social environment are associated with disease stage at diagnosis, receipt of treatment, and five-year survival for patients diagnosed with non-small cell lung cancer (NSCLC).
Methods and materials: This study was a retrospective cohort study of the Georgia Comprehensive Cancer Registry (GCCR) for incident cases of NSCLC diagnosed in the state. Multilevel logistic models were employed for five outcome variables: unstaged and late stage disease at diagnosis; receipt of treatment (surgery, chemotherapy, and radiation); and survival following diagnosis. The social and geographical variables of interest were census tract (CT) poverty level, CT-level educational attainment, and CT-level geographic residency status.
Results: Compared to urban residents, rural and suburban residents had increased odds of unstaged disease (suburban OR = 1.23, 95% CI: 1.11–1.37; rural OR = 1.63, 95% CI: 1.45–1.83). In this study, rural participants had lower odds of receiving radiotherapy (OR = 0.89, 95% CI: 0.82–0.96) and chemotherapy (OR = 0.92, 95% CI: 0.85–0.99). Living in CTs with lower educational levels was associated with decreasing odds of receiving both surgery (lowest educational level OR = 0.67, 95% CI: 0.59–0.75) and chemotherapy (lowest educational level OR = 0.74, 95% CI: 0.68–0.81). Living in areas with higher concentration of deprivation (high level of deprivation HR = 1.04, 95% CI: 1.01–1.09) and lower levels of education (lowest educational level HR = 1.12, 95% CI: 1.07–1.17) was associated with poorer survival. Rural residents did not show poorer survival when treatment was controlled and they even presented a lower risk of death for early stage disease (HR = 0.90, 95% CI: 0.82–0.99).
Conclusion: This study concludes that where NSCLC patients live can, to some extent, explain treatment and prognostic disparities. Public health practitioners and policy makers should be cognizant of the importance of where people live and shift their efforts to improve lung cancer outcomes in rural areas and neighborhoods with concentrated poverty.

1. Introduction

Among all cancers in the United States, lung cancer ranks second in incidence and first in mortality [1,2]. It is estimated that approximately 160,000 Americans will die from lung cancer in 2013, accounting for 26% of all female cancer deaths and 28% of all male cancer deaths [2]. Non-small cell lung cancer (NSCLC) is the most common type of lung cancer [3]. It is also one of the few cancers with high rates of unknown disease stage at diagnosis [4]. As stage of disease is used in making treatment decisions and is an important predictor of prognosis following a diagnosis of cancer [5,6], it is important to examine predictors of unstaged disease. Previous studies [7,8] suggest more research is needed to address unstaged cancer for several reasons: (1) an important proportion of cancer in populations consists of unstaged cancer, (2) these patients are less likely to receive treatment, and (3) unstaged patients have poorer health outcomes [7].

In the delivery of care for patients diagnosed with NSCLC, disparities that pertain to individual characteristics such as race [3,9,10], marital status, education, and age have been reported both in receipt of treatment and survival [11–14]. However, the impact of area-level social factors on NSCLC treatment and survival, especially in the U.S., has yet to be determined [15]. Furthermore, the

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impact of geographical location on the utilization and success of post-cancer care remains understudied. The spatial aspects of a patient's residence may explain patterns of receiving treatment and impact survival. Area-level socioeconomic status (SES) is useful not only because it can reflect individual SES [16], but it also provides information about the greater environment in which a patient resides [16,17]. Living in economically impoverished areas or rural environments are often associated with adverse health outcomes [18–20] and may reflect lack of access to care or the absence of a well-connected infrastructure to support cancer patients living in these areas [21].

Among the few studies that examined the association of area level characteristics with the receipt of treatment or survival for lung cancer patients, Pozet et al. [20] found higher risk of death for rural NSCLC patients. Another study that investigated a cohort of lung cancer patients, who received treatment in Duke Health System, found poorer survival for individuals that reside in low SES areas [21]. Shugarman and colleagues [22] found no relationship between rurality and survival although living in a low SES area was associated with poorer survival among Medicare beneficiaries. For lung and colorectal cancer patients, Campbell and colleagues [23] reported that as the distance to a cancer center increased, the odds of late stage disease at diagnosis increased. Likewise, Liff et al. [4] found an increased likelihood of late stage diagnosis for all cancer sites in rural patients, particularly for lung cancer.

The purpose of this study was to measure the extent to which geographic differences are associated with disease stage at diagnosis, receipt of treatment, and five-year survival for patients diagnosed with non-small cell lung cancer (NSCLC). The odds of unstaged and late stage disease at diagnosis, the odds of receiving treatment, and the risk of death constituted the outcomes of interest for this study. There were three social and geographical variables as exposures of interest all measured at the census tract (CT) level: CT-level poverty, CT-level educational attainment, and CT-level geographic residency status. The results of this study will identify area-level characteristics as determinants of lung cancer outcomes and identify targets where future interventions should focus their efforts to reduce these disparities.

2. Method

2.1. Participants, data, and design

The Georgia Comprehensive Cancer Registry (GCCR) retrospectively collects data on all incident cases of cancer diagnosed in the state of Georgia. The cohort for the current study consisted of incident NSCLC cases diagnosed in Georgia from January 2000 to December 2009 (N = 57,120). Participants were excluded from the study if: (1) the age at diagnosis was <50 or >85 (n = 6060), (2) they did not identify as black or white race (n = 372), (3) their ethnicity was identified as Hispanic (n = 401), (4) there were two or more primary tumors (n = 11,540), and (5) the tumor was diagnosed as small cell lung cancer (n = 5900). Individuals under the age of 50 were excluded because less than 10 percent of the disease is diagnosed in this age group where a considerable proportion of lung cancer in this group can be due to hereditary factors [24,25]. Additionally, patients with missing CT information were excluded (n = 136). This research was approved by the Institutional Review Boards of the Georgia Department of Public Health and Georgia Southern University.

2.2. Study variables

The GCCR collects demographic, tumor-related, treatment-related, and follow-up information on all cancer patients diagnosed in the state. The individual-level variables of interest included race, gender, age at diagnosis, date of diagnosis, tumor-related information (stage, grade), first course of treatment received, last date of follow-up, and vital status at last follow-up.

The GCCR also obtains the CT corresponding to the residential address for all cancer patients. In order to capture multiple dimensions of the social environment, the data were merged with U.S. Census 2000 data. Consistent with previous studies [26–28], factor analysis was utilized to create composite variables due to the highly correlated nature of variables comprising multiple dimensions of socioeconomic status (SES). The two composite variables indicated economic deprivation and educational attainment. A higher score indicates lower level of educational attainment and higher level of economic deprivation. As others have described [23,29], both indicators were classified into four categories based on the quartile distribution. In addition to the CT-level indicators, we obtained CT-level primary Rural Urban Commuting Area (RUCA) codes from the U.S. Department of Agriculture [30]. These codes have been designed to reflect population density and commuting patterns at the CT level. It should be mentioned that definitions of rural, suburban, and urban vary across studies. As previously demonstrated by other investigators of health-related outcomes [31–33], RUCA codes for each CT were applied to classify each study case as rural, suburban, or urban in the following manner: rural (RUCA codes 7–10), suburban (RUCA codes 2–6), urban (RUCA code 1).

2.3. Statistical analysis

Descriptive statistics are presented as frequencies and percentages for the categorical study variables according to geography. Differences in categorical variables were compared across rural, suburban, and urban geographic categories by Chi-square tests. All statistical tests were two-sided. $P < .05$ was considered statistically significant.

For the outcomes of unstaged disease at diagnosis, late stage disease at diagnosis, and receipt of treatment by type (surgery, chemotherapy, and radiation), logistic regression was utilized to obtain odds ratios (ORs) with 95% confidence intervals (CIs). To avoid residual confounding [34], patients with unstaged diagnosis (n = 3052) were excluded from all regression analyses except for the dichotomous outcome of unstaged disease. In all models, the unadjusted effects (not displayed) were obtained followed by calculating adjusted effects controlling for tumor stage, tumor grade, age, race, and sex. The effects of each of two constructs of interest (social environment and rurality) were examined in separate models where the fully adjusted model included the effects of all area-level variables together while controlling for individual-level variables.

In treatment and survival models, patients who died within 2 weeks of diagnosis were excluded from the analysis (N = 1889) to remove those who were not recommended any treatment due to poor prognosis because of comorbid disease or advanced lung cancer. This exclusion also removed cases diagnosed at autopsy. To assess the association for the exposures of interest on NSCLC participants' risk of death, a survival analysis was conducted. Five-year survival time was calculated from the date of diagnosis of NSCLC until the last day of follow-up, the date of death, or the termination of the study (December 31st, 2011). Patients who died after five years were censored at 5-years follow-up. Five-year survival was chosen as it is considered a benchmark for treatment success in cancer [15,35,36]. As mentioned for the logistic models, the survival model measured the effect of exposures in separate models while the final model included the effects of both exposure variables together. The Cox proportional hazards model was used to obtain hazard rate ratios (HRs) with 95% CIs for the relative risk of death.