Economic disparities in Appalachia linked to risk factors for long-term health for estrogen positive breast cancer patients

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A B S T R A C T

Background: Breast cancer is the second leading cause of cancer death for women in the United States and mortality from cancer is more common among individuals in the Appalachian region compared to the rest of the country. We examined how risk factors for long-term health outcomes for Estrogen positive breast cancer patients differed by county economic status in southern Appalachia.

Methods: Data was collected through retrospective data mining of patient medical files ($N = 238$). Using the self-reported zipcode, patients were classified into county economic status. At-risk and distressed designations were also rural counties. Bi-variate statistical analyses were used to evaluate how demographic, behavioral, health risk factors differed across economic statuses.

Results: For demographic factors, fewer single individuals lived in at-risk counties and older individuals lived in distressed counties. For health behaviors, more individuals in transitional counties report drinking alcohol but more individuals in distressed counties reported adhering to medication. For morbidity, more individuals in distressed counties reported having diabetes or a circulatory disease.

Conclusions: Many risk factors differed across county economic statuses. Therefore, doctors must consider the patient's context as a risk factor not just their individual characteristics. Patients from economically distressed counties may be at higher risk for treatment complications due to a larger proportion of co-morbidities and older age. Because many risk factors (eg, previous cancer, BMI) are similarly proportioned across Appalachian economic statuses, ER + breast cancer patients in Appalachia may be at a similarly high risk for health complications compared to the rest of the country.

1. Introduction

The cultural region of Appalachia is located along the central and southern portion of the Appalachian mountain range covering 13 states, 420 counties, and 205,000 m^2 with roughly 42% of its population living in rural communities [1]. In general, residents of the Appalachian region experience poorer overall health and higher poverty levels than the rest of the country [2,3]. However, economic and health disparities in Appalachia are not equally dispersed throughout the region. Meaning, there are counties of extreme economic poverty and other counties that are thriving. Similarly, concentrations of health disparities tend to overlap with rural and poorer counties, and in fact, the observed health disparities are partially caused by the county economic distress levels [4–6]. In terms of health disparities, Appalachia ranks below national average on 33 of 41 indicators of health with higher rates of mortality on many of the leading causes of death (eg, heart disease, cancer, injury, stroke, diabetes) compared to the national average [3]. Markedly, across Appalachia individuals have a 10% higher risk of dying from cancer compared to the rest of the county; moreover, individuals living in poorer and more rural Appalachian counties have 15% higher risk of dying from cancer [2,7]. Furthermore, Appalachians are less likely to engage in breast cancer early detection screening which further contributes to health disparities among women diagnosed with beast cancer [8].

Breast cancer is the most common type of cancer diagnosis and is the second leading cause of cancer death for women in the United States [9]. Furthermore, Estrogen-Receptor positive (ER +) breast cancer is the most common type of breast cancer for women [10]. Among Appalachian women with ER + breast cancer, the population density of a patient's town (ie, rural vs urban) is linked to adherence to medication which can reduce cancer recurrence [11]. Additionally, health behaviors commonly linked to ER + breast cancer prevalence, such as obesity and smoking, are also higher in Appalachia [1,2]. Therefore, ER + breast cancer patients in Appalachia may be at greater risk for health complications depending on their county economic status given their health and demographic factors at clinical intake. However, little is known about the social determinants of health, health behaviors, and morbidities among women in Appalachia and especially among those diagnosed with ER + breast cancer. Therefore, in order to assess the risk for longterm health complications, the present study examines how ER + breast cancer patients' county economic status is associated with social determinants of health, self-reported health behaviors, mental health, and past/present morbidities.

The study tests the following hypotheses:

Hypothesis 1. *Social determinants of health (eg, marital status, employment status, and age) differ across economic county statuses.*

Hypothesis 2. *Self-reported health behaviors differ across economic county statuses.*

Hypothesis 3. *Mental health history differs across economic county statuses.*

Hypothesis 4. *Co-morbidity differs across economic county statuses.*

2. Method

2.1. Patient population

After receiving IRB approval, patient names were retrospectively pulled from our prospectively maintained tumor registry for a 5-year period (2011–2016). Data were collected through examining patients' medical files of ER+ breast cancer patients who visited the doctor within the last three years and were female. The study included patients from the southern Appalachian area receiving treatment at a large academic medical institution.

The original sample included 633 patients across different economically distressed counties in East Tennessee as identified by the Appalachian Regional Commission (ARC). The ARC has 5 classificationse of Appalachian county economic statuses: (a) *Distressed* (rank economically worse than 10% of the nation's counties), (b) *At-Risk* (rank between the worst 10% and 25% of the nation's counties), (c) *Transitional* (rank between the worst 25% and the best 25% of the nation's counties), (d) *Competitive* (rank between the best 10–25% of the nation's counties), and (e) *Attainment* (rank in best 10% of the nation's counties). [3] Using the 2017 classifications, there were no counties in the patient population region (East Tennessee) which were classified as Competitive or Attainment. Therefore, we focused on the three poorest economic statuses: Distressed, At-Risk, and Transitional. In East Tenessee, the At-Risk and Distressed coutnies were all rural while the Transitional county was urban.

2.2. Measures

The predictor variable for the study was *county economic status* (1 = Economic Distress, 2 = At-Risk, 3 = Transitional). For the present study, the economic classification was determined by patient's zip code with 8.2% of the sample living in Distressed counties ($n = 52$); 13.5% of patients living in counties At-Risk counties ($n = 86$); and 77.74% of patients living in Transitional counties ($n = 495$). Because of this imbalance across county economic statuses, we randomly selected 100 patients living in Transitional counties to test the hypotheses on a more balances sample. The resulting final sample of 238 patients had a more balanced distribution across counties with 21.5% living in Distressed counties ($n = 52$), 35.5% living in At-Risk counties ($n = 86$), and 41.3% living in Transitional counties ($n = 100$). Distribution for all outcome variables are presented in Table 1.

3. Results

3.1. Demographic factors

Using chi-square tests, marital status was marginally statistically significant ($\chi^2 (6) = 10.88$, $p = .092$). After examining the adjusted residuals, we found similar proportions of married (Distressed = 64%; At-Risk = 69%; Transitional = 61%) and widowed (Distressed = 21%; At-Risk = 13%; Transitional = 12%) patients across county economic status. For single individuals, according to the adjusted residual, there was a smaller proportion of singles in At-Risk counties (4%) compared to Transitional (13%) and Distressed (12%) counties. In addition, according to adjusted residuals, there was a smaller proportion of divorced individuals in Distressed (4%) counties compared to At-Risk (14%) and Transitional (13%) counties.

Table 1
The distribution of outcome variables. For categorical variables, proportions (%) are presented. For continuous variables, means (M) and standard deviations (SD) are presented.

Variable level	%/M(SD)
Demographics	
Marital status	
Single	9%
Married	64%
Divorced	11%
Widowed	14%
Employment	
Yes	47%
No	8%
Retired	45%
Age	63.70(12.42)
Behavioral health	
BMI	
< 30 BMI	61%
≥ 30	39%
Tobacco use	
Current user	11%
Past user	19%
Never used	70%
Alcohol use	
Yes	34%
No	66%
Mental health	
History	
Yes	32%
No	68%
Morbidity	
Diabetes	
Yes	21%
No	79%
Circulatory disease	
Yes	68%
No	32%
Previous cancer	
Yes	17%
No	83%
Total number of morbidities	2.44(1.71)

For age we used ANOVA and found mean differences for age across county statuses ($F(2234) = 4.08$, $p = .018$). Post-hoc analyses indicated that the age of patients in Distressed counties ($M = 69$ years, $SD = 12$ years) was significantly higher ($p = .019$) than patients in At-Risk counties ($M = 62$ years, $SD = 12$ years) and marginally significantly higher ($p = .058$) than patients in Transitional ($M = 63$, $SD = 13$) counties. According to chi-square test, employment status was not significant ($\chi^2(4) = 3.55$, $p = .47$).

3.2. Health behaviors

We used chi-square to test if there were proportional difference in patients' health behaviors across county economic statuses. Alcohol use was significantly different by county status ($\chi^2(2) = 10.33$, $p = .006$) with patients in Transitional counties having the highest proportion of reporting alcohol consumption (43.4%) compared to At-Risk (34.1%) and Distressed (17%) counties. In addition, the proportion of medication adherence was different by county status ($\chi^2(2) = 8.90$, $p = .012$) whereby patients in Distressed counties had the highest proportion of medication adherence (100%) compared to those in At-Risk (81.4%) and Transitional (84.4%) counties. BMI ($\chi^2(2) = 3.42$, $p = .18$) and tobacco use ($\chi^2(4) = 3.16$, $p = .53$) were not significant.

3.3. Mental health

Using chi-square analysis, the proportion of mental health diagnoses did not differ across county economic statuses ($\chi^2(2) = 0.60$, $p = .74$).

3.4. Morbidity

To test Hypothesis 4, we first examined proportional differences of common morbidities (eg, diabetes, circulatory disease, previous cancer) across county economic status using chi-square. The proportion of *Diabetes* was significantly different across county economic status ($\chi^2(2) = 8.92$, $p = .012$) whereby the proportion of patients with diabetes was higher in Distressed (35%) compared to At-Risk (19%) and Transitional (15%) counties. In addition, the proportion of *circulatory diseases* was significantly different by county status ($\chi^2(2) = 7.55$, $p = .023$) whereby patients in Distressed counties had a higher proportion of circulatory disease (84%) compared to At-Risk (64%) and Transitional (64%) counties. The proportion of patient reports of *previous cancers* ($\chi^2(2) = 3.12$, $p = .21$) was not significantly different by county status.

Next to test Hypothesis 4, we computed the total number of self-reported diseases and determined if there were differences across county economic status using ANOVA. Results were marginally significance ($F(2234) = 2.46$, $p = .088$). Post-hoc analyses indicated that there was one difference whereby Distressed counties had a slightly greater frequency of diseases ($M = 2.86$, $SD = 1.77$) compared to At-Risk counties ($M = 2.20$, $SD = 1.64$); this difference was marginally significance ($p = .083$).

4. Discussion

Overall, this study examined how economic disparities are linked potential risk factors for treatment complications among ER+ breast cancer patients in Appalachia including demographic, health behaviors, mental health, and co-morbidities. While there are known health disparities among those living in Appalachia, little is known about how these health disparities are different across Appalachian county economic status for women diagnosed with ER+ breast cancer.

Hypotheses 1 was only partially substantiated, with women in Distressed counties being older on average but no difference was found for marital status and employment status, despite all being regularly linked to health disparities in Appalachian populations [1]. However, ER+ breast cancer patients in Distressed counties were significantly older than patients in At-Risk counties and had marginal significance for Transitional counties. This age difference could be a reflection of population migration as younger generations of people living in rural areas are more likely to relocate to more metropolitan and economically vibrant counties, largely due to education and employment opportunities [12,13]. Nevertheless, older average age may put ER+ breast cancer patients in Distressed counties at greater risk for subsequent health complications because older adults are more likely to experience fatal complications from treatment [14,15]. Further, it is notable that marital status was marginally significance, as this indicates a lower probability of individuals being married in Distressed counties. This is confirmed in other research which indicates that lower income individuals are less likely to marry [16]. Marital status has also been consistently linked to better health outcomes [17,18] and medication adherence among ER+ breast cancer patients [11]. Therefore, these marginally significant results warrant future examination to confirm if marital status is different by economic status and if these differences unequally influence the risk of health complications.

Hypothesis 2 was partially substantiated with alcohol and medication adherence differing by county economic status but not BMI or tobacco use. Compared to the rest of the country, tobacco use and BMI are higher in Appalachia. [2,4,5,19,20] However, the present findings indicate that among ER+ breast cancer patients these risky health behaviors are similarly proportioned across county economic status and therefore maybe a risk factor for treatment complications for all Appalachian patients and not just to patients who live in specific counties.

Conversely, alcohol abuse diagnoses are lower among the Appalachian population than national averages, though there is some indication that this difference may be due to patient under reporting [2,19]. For our sample, ER+ breast cancer patients in Transitional counties reported greater alcohol use compared to At-Risk and Distressed counties. However, upon examining the qualitative data, none of these affirmative reports would be diagnosed as alcohol abuse: "I have one or two glasses of wine" or "I drink socially". Therefore, this response might not be a measure of alcohol use but of patient-doctor disclosure. Meaning, patients in Distressed counties may be less likely fully disclose to their doctor what may be perceived as poor or unacceptable health behaviors compared to those in Transitioning counties. This conclusion can similarly relate to the medication compliance findings.

For our sample, a higher proportion of ER+ breast cancer patients in Distressed counties reported adherence to medication; in fact, 100% of patients from Distressed counties reported adhering to their medication. However, compared to national samples, medication adherence is lower among Appalachians, which is potentially linked to the high poverty rate (ie, inability to afford co-pays) [2] and distrust of medical professional recommendations [7,8]. This was a surprising findings, and while the reporting may be accurate, this might be a further indication that patients from Distressed counties are less likely to disclose health behaviors to medical professionals, especially those behaviors that are perceived to be unhealthy. If true, then ER+ patients from Distressed counties may be at higher risk for health complications as doctors are less able to intervene and potentially prevent complications without an accurate report of past and present health behaviors.

Hypothesis 3 was not substantiated, as the proportion of mental health diagnoses was not different across county distress status. One explanation for this lack of significance may be linked to the traditionally low rates of mental health diagnoses in the Appalachian area, which literature commonly contributes to social stigma of mental health helping seeking and low access to mental health providers [19]. Therefore, medical doctors may consider assessing for mental health symptoms rather than self-reported mental health diagnoses. A compilation of symptomology may provide a better assessment of risk factors compared to actual mental health diagnosis.

Hypothesis 4 was partially substantiated with a higher proportion of patients with diabetes and circulatory diseases from Distressed counties than in At-Risk and Transitional counties. These findings replicated previous literature research that has found both heightened levels of diabetes and heightened levels of circulatory diseases (eg, heart attack and stroke) in Distressed economic counties as compared to non-distressed counties in Appalachia [4,6]. Appalachia leads the nation for mortality as a result of cancer, diabetes, and heart disease [2], however, the proportion of previous cancers were not different by Appalachian county. It appears that patients from economically distressed counties are at a greater risk for co-morbidities and therefore a greater risk for treatment complications.

5. Conclusions

Though this study is limited by the self-report nature of the patient intake process, there are some notable conclusions that can be taken in determining patient potential risk for treatment complications. First, it appears that patients from economically distressed counties may be at higher risk for treatment complications due to a larger proportion of co-morbidities and older age. Second, there are a number of risk factors (eg, previous cancer, BMI) which are similarly proportioned across Appalachian county economic statuses. This may be an indication that ER+ breast cancer patients in Appalachia are at a similarly high risk for health complications compared to the rest of the country. Third, patient disclosure of health behaviors (eg, alcohol use and medication adherence) may be different by economic status because of known patient distrust of medical professionals. This lack of disclosure may be a risk factor for health complications as doctors may be able to less effectively or appropriately treat the patient without knowledge of these lifestyle

risk factors. Future research should further explore the prevalence of disclosure among Appalachian ER+ breast cancer patients.

Conflict of interest

No authors report conflict of interest with regard to the submitted manuscript.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ctarc.2019.100128.

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